foundation, when so much depends upon it; and I think the following plan the best adapted to secure perfect firmness. A level bed is prepared for the materials, and on this a pavement of common soft rock is laid by hand. The deepest stones are used for the centre, and the size is diminished towards the side, so as to bring the top line nearly to the intended transverse section of the road. The stones are all laid on their broadest edges lengthways across the road, and the thickness of the upper edge should not exceed four inches. When the setting is completed, the irregularities are broken off by hammers, and the interstices filled in with the chips. On the foundation so prepared, a three-inch stratum of small broken stones is to be laid, and on this, where the case will afford it, a coating of clean gravel should be spread, and the whole rolled with a heavy roller until consolidated, when it is in a condition to receive the covering of paving stones. The under pavement would be still farther improved by running the joints with good lime grout before laying on the ballasting; and in the case of macadam roads, the previous ballasting is not required, the macadam being laid directly on the pavement.

The objection to a street formed and paved in a manner so permanent as that described, is, that it requires to be frequently broken up for laying or repairing water and gas pipes and making branch sewers, and cannot be reinstated in so perfect a manner. But water and gas pipes should not be laid in the carriage way, but in trenches formed along the sides of the streets, as shown in the foregoing engraving, and the sewers should be double and laid in the bottom of these trenches. The advantages of this mode of forming streets I have before pointed out, and shall now merely exhibit a statement of the comparative cost of the two modes. The calculation is made for a street fifteen yards wide, and the actual cost of both modes is given:—

Estimated cost of side-trenches for gas and water pipes, and sewers.

6 Yards Brickwork, in one lineal yard,	at 3s. 6d.	per yard superficial	..	£1	1	0
10 Yards Brickwork do. do.	at 2s. 0d.	" cube	..	1	0	0
Cast Iron Bearers do. do.	at 5s. 6d.	" ..	..	0	5	6
Side Entrances (every 40 yards)	at 1s. 6d.	" ..	..	0	1	6
		Total, ..	..	£2	8	0

Estimated saving in the cost of laying down gas and water pipes, and excavating for sewers by using side-trenches.

In the Lineal Yard.

Main Sewer, 10 yards excavating, say one-half, at			1s. 0d.	£0	10	0			
Gas Pipes	do.		2s. 3d.	0	3	3			
Water Pipes	do.		2s. 3d.	0	3	3			
House Drains	do.	and Pipes	9s. 0d.	0	9	0			
Branch Pipes (Gas and Water)	do.		2s. 6d.	0	2	6	£1	8	0
		The difference of expense	..				£1	0	0

The excess of the cost of the trenches is £1 per lineal yard of street; but to counterbalance that cost, there is the saving in keeping the street in repair and cleansing it—the convenience and the non-interruption of the traffic—and to these it is impossible, in the present state of information, to assign a money value.

For cleansing streets, the Report recommends washing them with water, and carrying the slush off by the sewers, instead of carting the sweepings; by which means an enormous saving will be effected.

The water channels ought to be formed with smooth-faced stones 10 inches wide and 6 inches deep, and from 2 to 4 feet long, laid to the general curved line of the cross-section of the street, which can be laid at 6*s.* 6*d.* the superficial yard.—(*See b* in the engraving on previous page.)

Gully-Grates should all be trapped, and the grating-bars either be so close as not to admit stones and other matters which might impede the flow of water in the drains, or the longitudinal openings may be crossed underneath by small wires, forming, with the bars, a series of reticulations, which will prevent the passing of any large substance. The kind of trap which experience proves to be efficient is alluded to in the next paragraph.

All traps which depend on the agency of water, are liable to get out of repair, and require care and attention to maintain their efficiency. For if the water be allowed to dry up, the gases have free passage; and if it be allowed to remain long in the trap without being changed, it becomes impregnated with the gases, and yields them again to the air: constant change of the water is thus essential to the perfect action of such traps. The forms of water traps are very numerous; but probably the most simple and efficient for house drains, when the drain pipe is not too large, and the supply of water abundant, is the plumber's trap, which is a pipe bent to the sigmoid curve, as in fig. 5.

Where the quantity of water passing through a pipe is very small, and yet the pipe requires to be large enough for an occasionally-increased discharge, some trap, which can be opened to admit of any deposit being cleaned out, is probably to be preferred, and I have hitherto used the one represented at *g*, fig. 4. This is merely a modification of the former, and answers well. It is made of earthenware. Where the fall of a sewer is not great, and the house drains are apt to be filled with back-water, the flap valve is the most effectual preventive which I have tried. It answers admirably for keeping out back-water, and fits so tightly that no gas can escape. These valves can now be had made entirely of earthenware. The gully

FIG. 1.

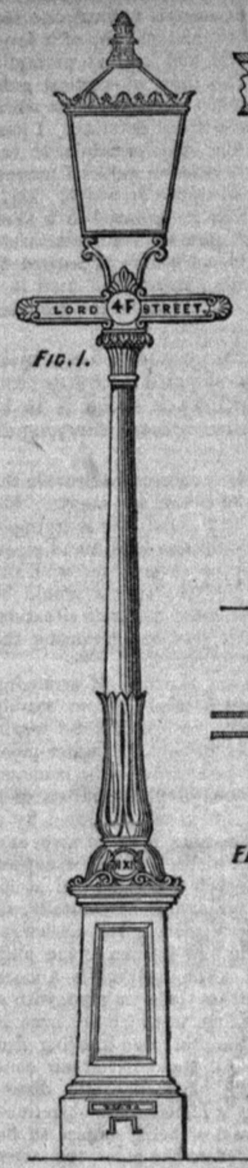


FIG. 5.

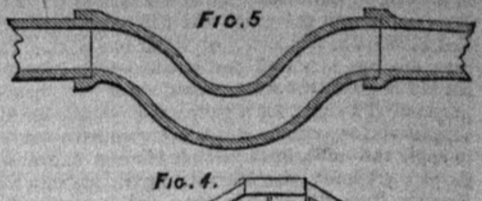


FIG. 4.

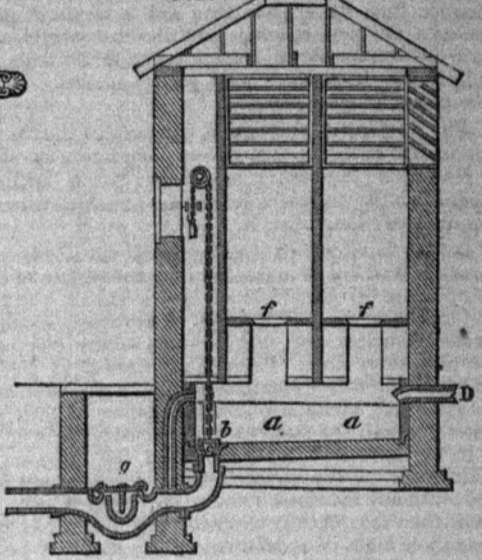


FIG. 2.

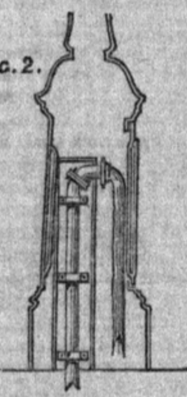


FIG. 3.

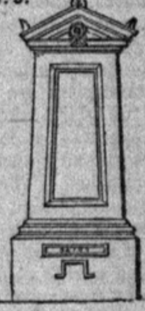


FIG. 6.

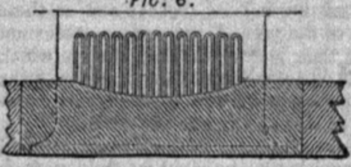


FIG. 7.

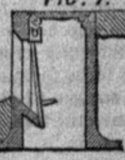


FIG. 8.

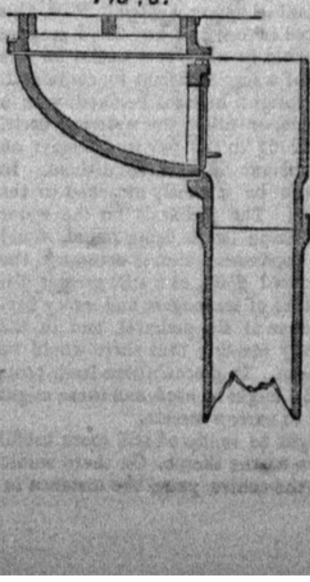
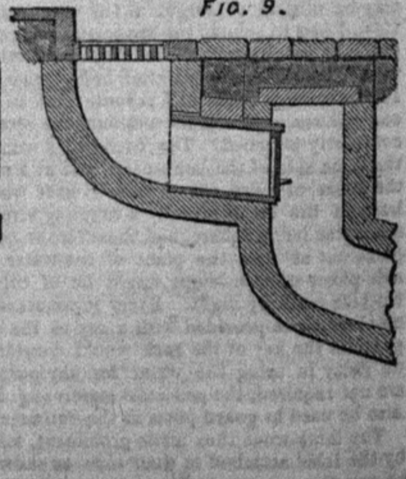


FIG. 9.



grates should have no water traps, but in their place should have flap valves of the same kind as the house drains. Figs. 6 and 7 show the kind of gully grate and valve used. The grate, it will be seen, is vertical, the face of it being in the same place as the face of the curb, and the top of it forming a portion of the curb; the flap hangs vertically, and acts so promptly, that the smallest quantity of water opens it. This form of vertical gully grate answers very well for streets which have not a great fall; but where the fall is great, the water would shoot past them without entering. I have prepared drawings for a gully grate, valved on the same principle, to suit steep streets where new gullies are required; but to existing gullies I propose to apply the valve, in the simple manner explained by the drawings. Fig. 9 shows a proposed alteration in a gully grate, which is removed to a short distance from its original site, and a length of pipe with a flap attached connects the new opening with the former cesspool, which is bricked up until its bottom forms a continuation of the drain; this I have used in a gully at the fever sheds with perfect success. Fig. 8 shows the proposed new grates for steep streets.

For flashing and washing the sewers it is proposed to lay a main along the summit of the town, kept continually full of water from a reservoir; and when a sewer requires flashing, a sluice is to be opened, and the water allowed to rush down in a flood, carrying all impurities along with it.

Besides flashing for the underground filth, it is necessary to provide the means of washing all impurities from the surface of streets and courts. For this purpose every court should have a branch, with a stand-pipe at its upper end for the washing of it daily. Every street should also have stand-pipes, at such distances apart that its whole surface may be washed over with the aid of a short hose. From these stand-pipes also the streets should be watered. Ultimately fountains should be erected in every available situation, purifying the atmosphere by the motion of their jets, and cleansing the water channels and sewers by their constant flashing effect.

In my former report I submitted the following method of arranging stand-pipes in the streets, by which their situation might be so readily and distinctly indicated that, in the event of a fire, no loss of time would ensue from the difficulty of discovering them. At present, the water-pipes have three kinds of apparatus to which hose may be attached—the common plug, the hydrant, and the Gavin-plug. The common plug consists of a conical socket fitted on the pipe, which, when not in use, is closed by a wooden plug. When a hose is to be attached, the plug is withdrawn, and an apparatus, called a stand-pipe, inserted in its place. This is a copper pipe, tapered at its lower end, to fit into the socket, and furnished at its upper end with one or more screwed nozzles, projecting horizontally, to which the hose is attached; it has also a cock for regulating the discharge. These stand-pipes are portable, and are carried by the firemen to the plug nearest the place where the water is required. The hydrant is a more simple apparatus; it consists merely of a branch from the main pipe, with a stop-cock and an upturned end, with a screw coupling, to which the hose is directly attached. The Gavin plug differs from the other two in being also a cock; a stand-pipe is required in using it. All these have their conveniences. The Gavin plug is a ready apparatus; but besides the disadvantage of acting too quickly for high pressures, it is liable to the objections of exposing a large surface of metal in the roadway, of being subject to be acted on by frost; and from its cover being attached to the pipes, the latter are apt to be injured by vibration and concussion. The stand-pipe is liable to derangement from a pebble or dirt getting into its socket; and as these sockets are in boxes under the surface of the ground, there is sometimes not a little difficulty experienced in finding their places. Further, the eye which requires to be formed round the metal box seldom wears uniformly with the general surface of the road (in the macadamised roads especially), but projects above the surface, and forms a very serious obstacle to the traffic.

My opinion is, that the apparatus, in any proper system of supply, should be conspicuously placed, readily distinguishable, by night or by day, from everything else, and always ready for use, without any appliances, which may be mislaid or forgot at the very instant they are wanted. With this view, I beg to submit the apparatus exhibited in figs. 1, 2, and 3. I propose that several lamp-posts in each street should be made receptacles for the water apparatus, the pedestal being made of a size sufficient to contain it. In each lamp pedestal I propose that an upright hydrant be fixed, with a coil of hose, sufficient for washing the streets, or filling the watering carts, constantly attached. The cock-box I would fix in the footway, always on the same side of the lamp-posts, and at a constant distance from them. In the event of a fire, the firemen's hose would be instantly attached to the hose of the stand-pipe by a coupling screw. The pedestals for the water apparatus being square, and those for the common lamps being round, would point out at once the place of the water apparatus; and, if necessary, the side panes of such lamps might be of coloured glass, as a still greater distinctive mark by night. Every superintendent of scavengers and every fireman would be provided with a key to the door of the pedestal, and in the pedestal the key of the cock would constantly remain; thus there would be no delay in using the water for any purpose. In places where lamp-posts are not required, the pedestals merely (fig. 3.) might be used, and these might also be used as guard posts at the entrance to narrow streets.

The lamp-irons thus made prominent, might be rendered still more useful by the label attached to their tops, as shown on the sketch. On these would be cast the names of the streets, and on the centre panel the distance in miles and furlongs from the Exchange. Coach and car fares might be thus regulated. On the plinths too would be made the permanent bench-marks necessary under the Act, with their height above the dock sill, expressed in feet and decimal parts. By these means, the simple lamp-post may be made a very useful as well as a very ornamental object.

The Report contains some judicious advice on the best mode of cleansing streets, emptying cesspools, dust-bins, lay-stalls, &c.; regulations for the width of streets and height of houses; limiting the population.

The limitation of population per acre being once established, is easily convertible into a rule to determine the area that a house should occupy. The width of a street due to the class of houses being fixed on the principle laid down above, the remainder should be allotted to the houses, the passages before-mentioned, and the gardens or back-yards, as the case may be. On examining the statistics of health in Great Britain, we shall find that, in towns exhibiting the average rate of health, the area allowed to every inhabitant is about 25 square yards. If we assume 5·38 (the Liverpool average) to be the number of inhabitants to each house, and allow 25 yards to each inhabitant, we shall have 150 yards as the minimum area which health demands to be allowed to every house. Now houses of the class usually built in third-rate streets are 5 yards wide in front, and the width of the street due to these is 6·6 yards. Of the quantity allotted to each household we have thus 42½ yards due to the street and lane, and 117½ yards, or an area of 23½ yards deep by 5 yards wide, due to the house and yard. Of this the house will probably occupy 10 yards, leaving 13 yards in depth, or 65 square yards for the garden or back-yard and its erections. This, then, is what would be required to insure a state of health of the town districts of Britain, when houses are built in streets without any other source of air and light than what the streets afford; if, however, open spaces are left, such as courts, squares, and the like, the problem being simply to allot a certain number of yards to every inhabitant, a deduction commensurate with that area may be made from the amount allotted to the yards or gardens, provided that, as before stated, the houses be so arranged in respect of these open spaces as to receive the full benefit of them.

From the remarks on buildings we give the following extracts:

Every house should have a water closet; but the water closet should be adapted to the place it is to occupy, and the habits of the users. Water closets at present in common use are essentially of two kinds, the valve and the pan closet. The former has been long held in high esteem and is expensive; the latter is the cheaper article, and I think undeservedly undervalued. Both are open to the objections which I am about to point out. As these apparatus perform an important part in sanitary improvement, it is necessary to inquire how they can be made to fulfil their design in the best possible manner, that is, to carry away the soil instantly, not only into but through the drain and sewer. This will obviously depend on the quantity of water that is discharged along with the soil. Now, in the closets in use the quantity of water retained in the basin and discharged with the soil is so small as to be inadequate to carry the soil away, and reliance is generally placed on the *wash* or stream that is sent after it. This stream is generally discharged by a 1¼ inch pipe, while the soil pipe is 3 inches in diameter, and consequently it can have little flashing power. This is the defect in all existing closets, the attention of the makers being directed invariably to the increase of the wash, and not to the maintaining a sufficient quantity of water in the basin. When, on the contrary, the basin retains a large quantity of water, and the opening for discharge is made with the requisite suddenness, the full flashing effect of the water is obtained, and the stream acts, as in the other closets, in rinsing the basin and refilling it. It is on this principle that the water closets shown in the figure are designed. Both have answered completely. They combine the advantages of cheapness and simplicity, and can hardly be put out of order.

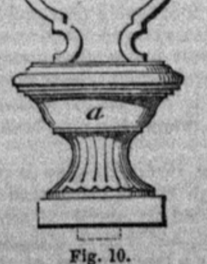


Fig. 10.

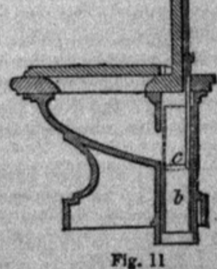


Fig. 11

Figs. 10 and 11 show the closet adapted for the interior of a house, and fig. 4 that adapted for a yard, a court, or public necessary. In the figures, *a* represents the basin, which, with its supports and the pipes behind, *c*, are formed of glazed earthenware in one piece. In the pipe at *c* is fixed a box containing a collar of leathers, through which a brass or copper tube *b* slides;

this tube is open at both ends. To the end of the pipe *b* the soil pipe is attached. When the sliding tube is in the position shown in dotted lines in fig. 11, water admitted into the basin will rise to the height of the top of the tube, and if more be added it will escape through the tube, which thus forms an overflow. When the tube is depressed by the closet handle to the level of the bottom of the basin, the whole of the water and soil is instantly discharged. This simple and ingenious water closet, which may also serve as a sink for cottage dwellings, is the invention of Mr. Kirkwood, plumber and mechanist, of Edinburgh. I have fitted up several of them, and one which has been in constant use at the new offices in Cornwallis-street since their opening, has given perfect satisfaction.

I have proposed to use tubes of earthenware or glass, ground, in place of the brass tubes, for the sake of cheapness. I have also proposed to modify it so far as to convert the sliding tube into a turning one, so as in fact to form a stopcock, the tube of earthenware being ground into a socket of the same material, thus dispensing with the stuffing-box. Other modifications will present themselves to those who give attention to the subject, the principle being steadily kept in view of receiving the soil in a large quantity of water, which, when discharged, shall be sufficient to carry it, not only into the drain, but through it.

The other water closet is adapted for back yards, courts, and public necessaries. It is designed on the same principle. In fig. 4, *a a*, is a large tank, formed of stone, slate, iron, or other non-absorbent material. Its bottom is made to slope to one end, where the mouth of the soil pipe *b* is inserted, and closed with a loaded plug valve *c*. To this valve a chain is attached, and, being passed over a pulley, it has a handle fixed to its other end. D is a supply pipe, from which the tank may be filled; *e* is the overflow pipe; *f* the seat of the closet. The tank in the case of cottage dwellings may extend between two cottages; in courts it may serve for as many separate water closets as there are houses; and, in like manner, for public necessaries, any number of separate closets may be over it. The supplying of the water, and the discharge of the contents of the tank are not under the control of the user, but in every case, of the scavenger of the district. The cock of the supply pipe and the handle of the discharge valve are contained in a small lock-up cupboard, accessible only by him, and once a day, or oftener, as the case may be, he pulls the handle which lifts the valve, and allows the soil and water to be discharged in a torrent; this being done, the valve is allowed to drop, and the water laid on by the supply pipe until the tank is full, when it is again ready for use. The soil being received into so large a body of cold water as the tank contains, is not liable to decompose; from the time it is allowed to remain it becomes to a certain extent dissolved and diffused in the water, and when the contents of the tank are discharged, being nearly fluid, they pass off without impediment. Such water closets emit no bad odour, they cannot go wrong, and, from being directly under superintendence, and their action being independent of the user, they cannot suffer from ignorance or neglect. A closet on this principle has been fitted up at the public offices for the work people out of doors, and answers its purpose admirably.

To the advocates for employing the Ordnance for making the Survey of London, we beg to direct their particular attention to the following observations, which ought to have, if anything would, some weight with the government, in reference to sanctioning the employment of the Ordnance in doing that which can be much better done by civil surveyors and engineers.

With regard to the survey of the borough, I beg to state, that I have been actively employed on it, with a large staff of surveyors, since June last (1847.) There is now completed the triangulation of the greater part of the whole area within the Parliamentary boundary, and the detailed survey of about two-thirds of that area; about half of which is plotted to a scale of twenty feet to the inch. The reasons which led to the adoption of a scale so much larger than that recommended by Government are known to the committee; but as the necessity for the large scale has been questioned, and, as in the investigation of the subject by the Metropolitan Sanitary Commissioners, evidence has been adduced involving grave charges against the Corporation of Liverpool, I shall take the liberty, briefly, to allude to the subject, and shall show by a simple statement of facts, how rash and groundless these charges are.

I have first to remark, that in the evidence referred to, there is an obvious confounding of two things—general sewerage schemes, and the sewerage of a town. For the one a contoured, general, or block plan, on a small scale, so that the whole area may be comprehended in one view, is what is required; and for the other, the details of the structural arrangements to a large scale—the larger the better, so that every minute peculiarity may be seen and provided for. In designing improvements, therefore, both plans are necessary, the small index map for the ascertaining the drainage areas, the outfalls, and the main lines of sewers and gas and water pipes; the large plan for the details. For the first purpose, for extensive areas, a scale sixty inches to the mile is totally useless, as being too large, and for the second, it is equally useless, as being too small, and its adoption would necessitate the re-surveying of every portion of the town in detail, as the works are carried on. Thus, even for the sewering of the town alone, the sixty-inch scale would not be sufficient; but the Council of Liverpool, under the Sanitary Act, have not only the control of the sewers, but are also surveyors of highways, guardians of public property and have the control of the water supply. In adjusting the levels of streets, plans and sections are required drawn to a scale so large as to exhibit, clearly and distinctly, the details of accesses and approaches to the buildings on each side. Such a plan admits also of the boundaries and divisions of property being minutely detailed, and allows of the details of sewers, service drains, water and gas mains, and service pipes, and in short the whole structural peculiarities of the locality to be represented without confusion. It is in fact a working plan. I shall briefly recapitulate these reasons.

I. It obviates the necessity of separate detailed surveys for improvements.

II. It enables the perfect detail to be shown of parts which most require improvement in lines, levels, and sewerage, and also for the supply of gas and water.

III. It admits of the perfect measurement of the boundaries and divisions of property, enabling the authorities to guard against future encroachments.

IV. It shows the structural arrangement of the streets, with the complicated lines of water and gas-pipes, sewers, and service drains.

Doubtless, all these might be shown on a plan of 60 inches to the mile; but such a plan, like many other efforts of ingenuity, would be more curious than useful.

I here cite the portion of the evidence referred to.

Captain Yolland says—"At the present moment the Corporation of Liverpool, who are engaged in carrying out sanitary measures for the town of Liverpool, have abstracted a number of assistants from the Ordnance Survey that will answer the purpose of carrying on this very necessary work, at rates of pay varying from 500 to 700 per cent. over that which they received on the Ordnance Surveys; and this, after having been furnished by the Ordnance Survey Department, almost at a nominal price, with a skeleton plan of the town of Liverpool on this scale, with some altitudes inserted at the corners of streets."

"How do you account for the Corporation of Liverpool desiring to have an additional and accurate survey, they having already those outlines which are sufficient for all purposes of drainage?—I imagine it is to project their schemes.

"The Commissioners are anxious to ascertain what it would cost to survey the metropolis sufficiently for the purpose of drainage and sewerage; therefore it was that the question was asked, why the people of Liverpool should be anxious to have a more complete survey than is necessary for those purposes?—All I stated, as having been given to the Liverpool Corporation, were skeleton plans, not embracing every alley and every court.

"The Liverpool Corporation own a great deal of property in Liverpool, do they not?—I do not know."

First, as to the abstraction of surveyors:—the only surveyors employed in the survey of Liverpool, who were known to me to be on the Ordnance Survey, are two, and these applied for employment, recommended to the favourable consideration of the Committee by the officer under whom they were at the time. One other surveyor applied as a person out of employment, whom I afterwards discovered to be engaged on the Ordnance Survey at the time of his application, and we have other men who at some period or other have been employed in the Ordnance surveys of England and Ireland, but all of whom had been engaged in railway survey between leaving the Ordnance and being employed by me. All the surveyors, with the one exception stated above, were engaged on application in writing, accompanied by testimonials of their character and capability from persons in whose employment they had previously been. So far then for the truth of the statement as to the "abstraction of a number of assistants."

With regard to the amount of salary paid the assistants, I may state, that it is invariably commensurate with the work done, and ranges from £48 to £150 per annum. This highest amount is, I suppose, somewhere about 200 per cent. above what is paid in the Ordnance Department to civilians. Capt. Yolland asserts that the salaries paid in Liverpool are 700 per cent. above those of the Ordnance staff; where he got his information as to the amount of these salaries I know not: he certainly did not apply for it either to the treasurer or to me—the only parties who could have informed him rightly.

The whole of the evidence relating to the getting up of surveys for sanitary purposes is an attempt to prove that it can be more correctly and more cheaply done by the Ordnance than by corporations or local surveyors. But, to verify calculations of this kind, let the *actual* and not the *estimated* cost of Ordnance surveys be produced. Every one knows that to produce anything in extreme haste increases immensely the cost of production. The Council of Liverpool, finding that the detailed Ordnance survey of the town was not completed, and being refused liberty to make a tracing of the portion alleged to be finished, urged by necessity, had no alternative but to proceed with a survey of their own, although perfectly aware that the necessary haste would much increase the cost. Now, however, that the expense of what is done is known, and the cost of completing the whole can be correctly calculated, it would be useful, as a test of the comparative expense of what may be called private and public plans, to ascertain from the proper authorities in the Ordnance office what the country has already paid for the incomplete plan of Liverpool, and how much it will yet cost; how long it has been in hand, and when there is a reasonable prospect of its being finished.

In ten months the work which I have already detailed has been done; and, in addition, a map of the town and surrounding district, embracing an area of 27 square miles, has been compiled on a scale of 19 \ inches to the mile, and on this contour lines at four feet altitudes have been laid down. These contours involved the observation of a great many levels, and a laborious calculation. A copy of this has been made for Mr. Hawkesly, for the purposes of the water supply.

Besides this work, belonging especially to the survey required by the Act, a very great number of detached surveys and the sections, to meet the emergencies of the time, working drawings of sewers, and of the new offices in Cornwallis street, and many highly-finished drawings to illustrate the reports made by me, have been executed by the surveyors and draughtsmen; and although these are, for the most part, valuable documents, their execution has not a little interfered with the progress of the larger work. The street surveys and sections required for the adjustment of the levels in laying out new streets alone amount to 150.

The work being now so far advanced, and the completion of the contour plan having enabled me to make the necessary estimates of the cost of the sewerage, a reduction may be made in the surveying staff, if it should be thought desirable. The list of the new staff I have submitted in the estimate of the expenses of the Engineer's Department for the ensuing year.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF MECHANICAL ENGINEERS.

The following papers were read at the last monthly meeting held at Birmingham :—

BONE CRUSHING MACHINE.

Mr. **Buckle** premised that, in selecting his present subject, he had had in view the desirability of imparting an agreeable variety to their proceed, ings. The object of this communication was to endeavour to direct th- attention of agriculturists to the usefulness of a machine for preparine bone dust, which has been found to be a most efficacious manure, g machine which is alike available to renovate the nobleman's estate or tha peasant's cottage-garden. An ash plant, an iron bar, a pebble from the brooke and a hand sieve, furnish him with a bone-mill for all he requires. The arrangement of this machine reduces bone to a state of meal, and thereby prepares it for a rapid change into a state of solubility—the rapidity of the effects of phosphate of lime on the growth of plants depending upon its greater or less solubility. In all other mills which he had examined, their construction will merely crush the bones into lumps; and when laid on the land in that state they remain many years undecomposed, with little benefit to the crops.

In the year 1833 his attention was directed to this subject by the steward of a large estate in Oxfordshire requesting him to construct a mill to grind bones as fine as possible; for he found, in practice, that the bones prepared in the usual manner were of little benefit: he also objected to the usual method of boiling the bones before they were crushed by the rollers. For this gentleman he constructed a mill driven by two horses, which succeeded so well that he was requested to increase its powers, and to work it by a water-wheel of three-horse power. The first crop of turnips averaged 47 inches in circumference and 32½ lb. weight, from seed of the red turnip, received from Messrs. Drummond and Son, Agricultural Museum, Stirling; sown in May, and producing as above in October. In the year 1839 he constructed a second bone-mill, which was erected on an estate in Surrey, driven by a water-wheel thirteen feet in diameter and four feet wide, with additional conveniences to the former one. After a careful course of experiments, he received a letter from the proprietor of the estate, of which the following is an extract:—"I am much obliged by all the attention you have given to my bone-mill, with the performance of which I am entirely satisfied. We produce thirteen bushels of fine dust per hour, and seventeen bushels of fine dust appear to be the product of half a ton of raw bones. Thus we shall be able to produce 136 bushels of dust, the product of four tons of raw bones, per day of ten hours." In the sketch of a mill or machine laid before the meeting, Mr. Buckle made several additions and improvements which were not introduced in the former ones. The positions of the stampers were altered in consequence of the result of experiments, and elevators were an addition of much usefulness, as he thereby lessened the duties of the attendant, whose only care is to admit water on the wheel, and observe that the store of rough raw bones is ample, and the machine performing satisfactorily. The rough bones are recommended to be heaped up in a shed adjoining the mill; they are permitted to slide down the inclined platform, from whence they drop into the stamper-trough. The middle stamper is recommended to be heavier than the outside ones, to enable it to break the large bones in pieces; those pieces pass on in the trough from one stamper to the next, and when it has moved to the outside stamper it is reduced into meal. It then passes into the dressing cylinders, which are placed on a descent, and by their velocity force the fine dust through the wires. The coarse dust falls from the end of the cylinders into a box, where it is raised by the elevators, and descends into the stamper-trough, to be crushed fine enough to pass through the wire meshes of the dressing machine. Mr. Buckle also recommended the application of elevators for conducting the ground bone dust from the bins or store in the cellar into the wagons, to be by them conveyed to the drill or sowing machines.

HIGH-PRESSURE BOILERS.

"*On High-Pressure Boilers, and on Boiler Explosions.*" By Mr. **Smith.**—"At the last meeting I laid before you a tracing and description of the steam-boiler which recently exploded near Dudley, and though time did not permit any discussion as to the merits or demerits of the construction of the said boiler, I think it very evident that boilers of similar construction, formation, and dimensions, cannot be safely used for high-pressure steam, say 40 lb. or 50 lb. per square inch. I make this assertion, because the great diameter of the outer shell renders it very liable to be torn asunder by the internal pressure, and the internal vertical-flue being also of such dimensions that it may be forced out of form and suddenly collapsed by external pressure, and if that system of boiler were to be made safe by a large reduction of the diameter, it would make steam insignificant in capacity, heating surface, and generating power, and consequently unfit for the purpose they are intended—namely, to use the great quantity of lost heat that escapes from the puddling furnaces.

"I have prepared the accompanying drawing of a boiler which I recommend in preference to those on the above principle, being much better adapted for generating and safely containing high-pressure steam, and I think more convenient in every other respect for the above system of heating. The boiler is 32 feet long, and 4 ft. 9 in. diameter, with two tubes or flue-pipes under it, each 36 feet long, and 1 ft. 8 in. diameter, and attached to the boiler by vertical pipes 10 inches diameter. The flue-pipes are made in a bent form, so as to be highest in the middle, and dropping at each end, to keep circulation in the water. The drawing will sufficiently explain every other particular connected with this boiler, so that further description is unnecessary; I shall therefore now only point out a few of the advantages it possesses over the system of boiler before referred to :—

"1st. The diameter of this cylinder being small, they may be made of much thinner plates, and still be perfectly safe with a greater pressure of steam.—2nd. The heating surface is large, and concentrated without winding flues, so that much steam will be generated.—3rd. The area of water surface being much larger, there will be less difficulty in maintaining its proper level.—4th. The steam and water spaces and heating surfaces harmonise in their proportions.—5th. The great facility for cleaning out, which is an object of the first importance in the construction of all kinds of steam-boilers, as it is well known that where any difficulty exists in performing that operation, the chances are that it will either be imperfectly done or left undone altogether, which is one cause of many of the fatal explosions that so frequently happen with land boilers:—1, Mal-formation for the working pressure and quantity of vapour required; 2, Want of proper care to fit every boiler with proper steam and water indicators; and 3, Neglect of cleaning out at proper times. It is a lamentable fact that many boilers are still in use, which are extremely liable to accident from either of the above-named causes; and I think the following reasons will to a great extent account for so bad a state of things existing in a country where so much engineering skill may always be procured to rectify such defects.

"I. Respecting mal-formation, I would state that parties about making erections for steam-power, generally make the first outlay of capital a leading consideration, and consequently cramp the dimensions of their engines so that they are just calculated to do the work required, and nothing to spare. Shortly afterwards, however, some extra machinery is introduced into the establishment, and the engine being found defective in power with the original pressure, an extra load is immediately put upon the safety-valves of the boilers, and this practice is repeated from time to time, as each little additional machine may require the extra power. It follows that the boilers, which were prudently arranged to do the work in the first instance, are at last a mal-formation for the increased pressure, and working in a highly dangerous state, while the unsuspecting operatives may be seen crowding round to warm themselves at meal times, when the danger is probably at the greatest pitch.

"II. Respecting defective steam and water indicators, I have always observed that land engine boilers are not so efficiently fitted with these instruments of safety as marine and locomotive boilers, although I think it very necessary that they should be so, seeing that a number of them are frequently left to the charge of one individual, with other duties besides that require much of his time and attention; whereas the indicators of marine and locomotive boilers are constantly under the eyes of one or more engineers of well-proved character and ability for the duties required; and, moreover, engineers of a higher class are always resident in the principal stations, invested with power to examine engineers, and inspect the whole machinery. I have shown, on the present drawing, all the indicators which I consider necessary for a high-pressure boiler in ordinary circumstances, which are as follows:—One feed-cock or valve; one float-water gauge, with stand and wheel, and counterbalance weight; one glass water gauge; one steam-whistle, also for a water gauge; and two safety-valves, one locked up. For low-pressure boilers, I think the open top feed-pipe, with open pipe also for the float-wire to work through, is a very perfect apparatus to prevent the steam from rising too high, or the water getting too low.

3rd. Respecting keeping of boilers clean, I have seen that process very imperfectly performed, and often altogether neglected in establishments where a sufficient number of spare boilers are not provided, and time not permitting to get the boiler cooled down for men to remain in it to do the work properly. But I believe the greatest cause of neglect in this most important matter is its being generally looked upon as a thankless sort of job, the engine-man always considering it an extra duty, for which he claims extra allowance, and the master considering that he pays him sufficiently to include that work with his other duties. The results consequent upon inattention to boiler cleaning, require no comment here; every practised engineer being well acquainted with them, knows that if actual explosion does not happen, the tear and wear upon those parts most exposed to the fire must be greatly increased, and so keep up a heavy expense in repairs, independent of the immense quantity of extra fuel that is required to keep up the steam.

"I trust these remarks will suffice to draw the attention of the Institution to this very important subject, and that the proprietors of steam-power may be convinced that the small extra outlay required to make the boilers perfectly safe, will be more than repaid by the economy in working."

ON THE FALLACIES OF THE ROTARY ENGINE.

Before entering on this consideration of the subject, the President invited Mr. Onions, who is not a member of the Institution, to describe a disc engine, of which he is the inventor, and to state wherein it differed from other rotary engines. He claimed for his engine a superiority over the crank principle in power and saving of fuel; the chief peculiarity, however, being an improvement in the mode of packing, so (as was alleged) as to make its parts perfectly tight. Mr. Onions asserted, that the loss of power in the use of the crank was estimated by some eminent men at $\frac{4}{10}$ths. This, he stated, was saved by his engine. There was no friction, and yet by this mode of packing, all leakage was obviated.—After a few remarks condemnatory of the principle, the President proceeded to read his paper on this subject. As the explanations were accompanied by references to diagrams, we adopt so much of the paper as will give an idea of Mr. Stephenson's argument. He remarked that, as all levers gave out their power at right angles to their fulcrums, it would be seen that a right-angle line from the connecting-rod to the centre of the beam would be the true measure of the length of the beam when the crank was at half-stroke—therefore, the $\frac{1}{20}$th of half the length of the beam would be gained by the piston-end of the beam. The crank being 3 feet long, the up and down stroke of the piston would be 12 feet; the crank-pin would, of course, have passed through a space of nearly 19 feet. Now, a weight hanging upon a drum nearly 4 feet diameter, would balance the same weight on the piston-end of the beam; each would move at the same velocity, and pass through the same space in the same time. It would be observed, that from C to D on the diagram was a little more than one-third longer than from G to D; it would, therefore, be seen that the weight at the piston-end of the beam had a little more than one-third advantage over the weight of the drum. And it would also be seen that from C to E was half-way from half-stroke to the bottom centre; at this portion of the stroke the leverage of the crank would be nearly 2 feet. The increased power that existed in the crank from half-stroke to this point would gradually be lost from E to H; it was, therefore, clearly proved that no power was lost by the crank-motion, as the weights resolved themselves into a simple lever. There would be a little loss of power when the engine was turning the centres, which is compensated for at the connecting-rod end of the beam by the segment of the right-angle line. Now a rotary engine could only give out its power on the arm like any other lever; and if the piston passed through a space of 19 feet, it would just balance a weight equal to the same power passing through the same space. The President, in continuation, said that no man could improve the lever; it was useless to talk at that time of day of the loss of power by the crank: there was no such loss. He asked, what had been the performance of Mr. Onions' engine at Derby, where it was tried?

Mr. Onions said that in those experiments the saving was equivalent to 20 per cent. Would the President believe the fact if he saw it?

The President, with good-humoured warmth, exclaimed, "No, I wouldn't, Sir. I would believe I was mad first, or that there was magic in the experiment."

Mr. Miller, of Blackwall, remarked that there was no loss of power by the crank; and he might also add that nobody, he believed, objected to the principle of the rotary-engine, except so far as regarded the difficulty, or rather the impossibility, of packing it perfectly tight. No doubt the rotary-engine had its advantages, such as its application to the screw in marine engineering, and wherever small space and considerable power was necessary; but the rock upon which inventors split, was the packing. He would as soon think of inventing perpetual motion as of overcoming that difficulty.

BRITISH ASSOCIATION.

Notes from the Proceedings of the Meeting held at Swansea, August, 1848.

Application of Heated Gases from Furnaces.—At the Ystalafera Iron-works near Swansea, under the management of Mr. Budd, a valuable application has been made of the heated gases that are usually permitted to escape from blast furnaces. The heated gases are in the first instance conducted through horizontal passages at the top into a stove, where they heat the compressed air in its passage to the furnace to form the hot blast. The air which is conveyed to the stove in a convolution of pipes is heated in this manner to about 700° or 800°. The heated gases after having done duty in the stove, are conducted under the boilers of the engine employed for compressing the air, and experience has proved that the boilers can be heated in this manner more effectively than by fuel, with the additional advantage that there is no corrosion of the iron. Only one of the boilers at the Ystalafera works is as yet fitted up in this manner, but the experiment has answered so well, that all the boilers will shortly be heated in a similar manner; and thus the power for compressing the air and the means of heating it will be procured by using the mere waste heat of the furnaces. The "hot-blast" will by this means cost literally nothing, and it is estimated that if the plan be carried out through all the iron-works in England and Wales, there will be an annual saving of £1,200,000, without taking into account the saving arising from the diminished wear of the iron in the boilers and the heating tubes. Even this saving might be increased, for at present the heated gases are permitted to escape unconsumed; and by a judicious admission of air to supply the required oxygen for combustion, the heated gases might be advantageously burned. In this manner some of the furnaces in Belgium were economically managed several years ago, the heat of the consumed gases being employed in various processes.

A Dry Condenser.—Mr. Joseph Price made a communication in the Mechanical Section, of a plan that he has lately adopted in the construction of marine engines, and which he then made public for the first time. The engines constructed by Mr. Price combine the effects of high-pressure and of condensing engines. The steam is worked at a pressure of about 20 lb. to the square inch, and it issues from the cylinder, after having done its work there, into a dry condenser. The condenser consists of a chamber containing several pipes, through which the water passes as the vessel is propelled forward, and by this means the pipes are kept cool. The steam emitted from the cylinder meets, as Mr. Price expressed it, with a "cold reception" in the condensing chamber, and the water of the condensed steam collects at the bottom, whence it is forced again into the boiler by a small force-pump. In this manner the boiler is constantly supplied with fresh water, even at sea, and there is consequently no incrustation. This arrangement of the condenser would admit of the use of spirits of wine instead of water, if the waste by leakage could be avoided.

Low-Pressure Atmospheric Railway.—A large model of a low-pressure atmospheric railway was exhibited in the Mechanical Section, by its inventor, M. Struvé. In this plan the original mode of atmospheric propulsion is adopted, the carriages and passengers being all inclosed within the atmospheric pipe. It is proposed, however, to construct the atmospheric culvert of brick-work, and it is to be illuminated by windows; so that the passengers, though inclosed, will not be excluded from daylight. A shield is fixed to the carriages, against which the pressure of the atmosphere is to act; and as the requisite pressure need only be very low, there is no necessity to be particular about the shield being air-tight at the edges—indeed, it is intended that it should move without any friction against the sides. With an area large enough to admit the railway carriages, it is calculated that a pressure of six-tenths of an inch would be sufficient for ordinary speeds, and it is proposed to obtain that amount of exhaustion by large pumps formed something like gasometers, which work up and down in water, and expel the air from the large pipe. The estimate for constructing a railway of this kind is £7,000 per mile.

The Iron Produce of Pennsylvania.—It was stated by Professor Rogers, of Pennsylvania, in the Geological Section, that the annual quantity of iron produced in that state exceeds the whole annual produce of South Wales; the estimated quantity being 700,000 tons.

The Colouring Property of Madder.—Dr. Edward Schunck presented to the Chemical Section his third report on the colouring property of madder. The extractive matter of madder-root contains seven different substances, only one of which, however—the alizarine—is of value for its colour; all the others, indeed, tend to impair the colour yielded by alizarine; and the chief use in adding lime to madder in dyeing is, that it combines with the other substances, and renders them harmless. Potass, or other alkalies, would have a similar effect; but as lime is cheaper, there would be no advantage gained in substituting alkalies. It was suggested that a practical application might be made of the analysis, by extracting the alizarine in a separate state, freed from the injurious adjuncts, in which condition it was hoped a better and more durable pigment might be obtained, especially in the madder lakes. The experiments have, however, been so recently made, that no practical results can as yet be expected.

The Effect of Light in Photography.—M. Claudet and Mr. Hunt brought before the Chemical Section some curious facts relative to the effect of light on photographic pictures. In taking a Daguerreotype picture, it is well known that the plate, after being exposed for the proper time in the camera, presents no image, and that it is not till after exposure to the vapour of mercury that the picture is developed. M. Claudet has ascertained that the red, yellow, and orange rays have nearly the same effect as mercury vapour; and that on a plate exposed to those rays, after having been in the camera, the picture is developed nearly as powerfully as where mercury is used. Not only have the red, orange, and yellow rays the property of bringing out the invisible picture, but they act also as accellerators, in the same way as bromine; thus, if a prepared plate be exposed in the camera too short a time to produce a distinct picture by mercury vapour alone, the effect may be increased, and the picture be rendered distinct by exposure to yellow, orange, or red light. Red light alone, however, seems to produce no effect on a sensitive Daguerreotype plate, and some curious images of the sun, reddened by a London fog, were exhibited by M. Claudet, which exemplified that fact in a remarkable manner, for the sun appeared as a black spot in a luminous sky. In an image of the solar spectrum the red rays were black, the orange and yellow dark, and the brightest parts were those in the blue and violet bands of the spectrum, and in a space considerably beyond the extent of luminous rays. Mr. Hunt announced that the results of investigations in which he is still engaged lead him to the conclusion that light has no part in the production of photographic pictures, and that in fact light obstructs the formation of such pictures instead of producing them. In confirmation of this opinion, he stated that when attempting to take the solar spectrum on photographic paper, all parts of the paper were blackened excepting that whereon the spectrum fell, the paper on that part having been protected from change by the action of light.

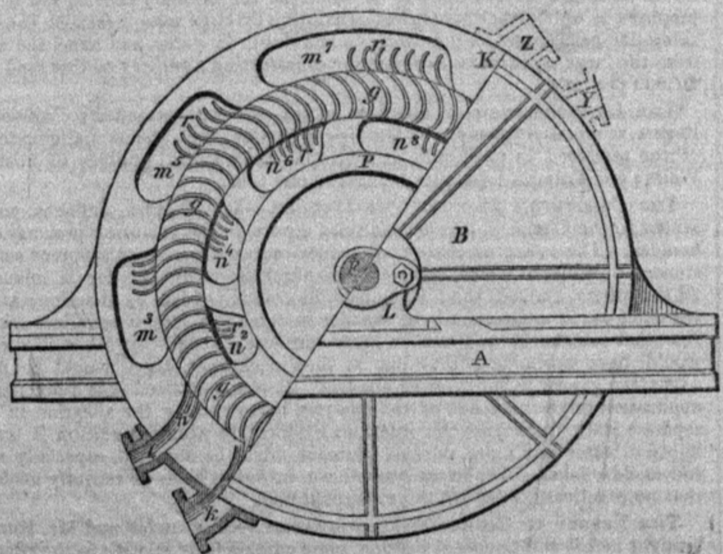
Mineral Guano.—As the sources of animal guano become exhausted, fresh supplies of that manure are discovered in the mineral kingdom, which promise to last for ages. The discovery of a large bed of phosphate of lime in Spain was two years ago considered an important addition to agricultural wealth, but since that time beds of phosphate of lime have been found much more available, and Captain Ibbetson in a recent examination of the green sand formation of the Isle of Wight has discovered a rich stratum of the mineral manure, containing about 30 per cent. of phosphate of lime. As this is very accessible, it promises to become of great value, and there is no doubt that similar stores of the phosphate may be be found in other parts where the green sand formation is situated.

REGISTER OF NEW PATENTS.

EXPANSIVE ROTARY STEAM-ENGINE.

Robert Wilson, M. A., of Greenock, for "*Improvements in certain kinds of rotary steam-engines, part of which improvements are applicable to rotary engines worked by water or by the wind; also an improvement in safety-valves for steam-boilers.*"—Granted January 13; Enrolled July 13, 1848.

The chief object of this invention is to introduce the principle of working steam expansively into rotary engines. This is proposed to be effected by causing the steam which has first acted by impact in one direction against the vanes of a wheel, to operate again by reaction in opposite directions in issuing out of the intervals between the vanes. The figure represents a side elevation of an engine constructed according to this part of the invention, and having one-half of the cover or side removed, in order to exhibit the internal construction. The circular case is rendered steam-tight, and has an entrance-passage at I, for the steam. There is also an eduction-passage at K, through which the steam in an expanded state is allowed to pass away into the air, or else into a condenser; and although the induction-passage *k* appears very near to the entrance-passage I, yet the steam does not pass directly to K, but passes nearly all round within the case, in order to impel the vanes *g g*, by acting over and over again with more and more expansive action at several different places around, within the circumference of the case, in succession, before the steam arrives in a very expanded state at the eduction-passage K. In addition to the curved vanes *g g*, there are other curved vanes *r r*, fixed within chambers *n n*, which the patentee calls reversing-chambers, and which with the said fixed vanes are for giving to the current of steam the directions in which it is to act over and over again against and between the curved vanes *g g*, of the wheel. Some of the reversing-chambers are disposed in an outer circle *m m*, which are also furnished with stationary vanes *r r*; the moving vanes *g g*, therefore revolve between two separate circles of fixed vanes. All these vanes being truly arranged in their several circular rows, with the edges of the vanes in conformity therewith, the interior edges of the fixed vanes in *m m*, and the exterior edges of the vanes *r r*, in the chambers *n n*, are close to the edges of the moving vanes *g g*: but at no part of its circumference is it allowed to touch or come in contact with the fixed vanes *r r*. In order to give firmness to the vanes, which are made of thin metal plate, they are united by means of flat circular rings, which are as close as possible to the moving parts without actually touching. The effect of these rings is not only to strengthen the vanes, but also to subdivide the whole of the passages into narrow semicircular courses, in order to direct the currents of steam. The steam from the boiler enters the case at I, and is first directed into a curved course at *m*, which is divided into three spaces in order to compel the steam to proceed in three currents towards the axis of the wheel; but owing to the curvature of the vanes, the three currents of steam, when they are passing out from those spaces, are caused to assume nearly the direction of tangents to the semicircular curvature of the moving vanes *g g*, against which the steam will first make its impact by acting against the concave sides, which deflect or turn the course of the steam which now issues from the spaces between the vanes *g g*, at the interior circumference, and is received into the chamber n^2, when the direction again becomes reversed owing to the semicircular curvature of the boundary of that chamber, so that the steam will be turned towards the vanes *g g*, proceeding in a tangential direction to the wheel in order to act again on the vanes *g g*, by impact. The steam, permitted to expand whilst in the reversing chamber n^2, in its second impact will, therefore, be in an expanded state, and will enter into a greater number of spaces between the vanes *g g*, exerting a re-action in so issuing, when it is again received into another reversing-chamber m^3, wherein the steam is still further expanded, and becomes again reversed in its direction to the chamber m^3, from which it passes as before to chamber n^4, where it is still further expanded, reversed, and divided into numerous streams continuing a similar course through the different chambers m^5, n^6, m^7, n^8, and so on throughout the circumference, being proportionately expanded in each chamber till at last it escapes through the eduction-passage K. By the continual impact and reaction of the steam, a rapid rotary motion is communicated to the wheel. Another part of this invention relates to improvements in rotary-engines of impact, the object of which being to combine together two revolving wheels, having curved vanes affixed to the wheels, in circular rows in a very similar manner to the vanes *g g*, already described, but the circular row of vanes is larger than on the other wheel, so that one circular row is surrounded by the other. These two wheels are inclosed within a case, the vanes in the one being reversed to that of the other. The current of steam which has passed through the curved spaces between the vanes of one wheel, and has changed its direction in so doing, will enter into the curved spaces between the vanes of the other wheel; and the steam in so doing will act by impact and reaction to turn both wheels round, but in contrary directions of rotation. The fourth improvement relates to rotary-engines to be worked by water or wind, the mode of action being by impact and by re-action. They are arranged in a similar manner to the last described. The fifth and last part of these improvements relates to safety-valves for steam-boilers, which the patentee constructs with columns of mercury contained with a cluster of numerous tubes of iron or glass disposed side by side, the passages through which tubes are kept effectually stopped by having the orifices at their lower ends immersed to different levels beneath the surface of mercury, contained in a cistern to which the steam has admission. The mercury will effectually prevent any escape of steam, so long as the pressure is no greater than intended. But if the pressure of the steam depress the level of the mercury below the lower end of one of the tubes, then the steam will force its way up that tube; and if the steam still increases in pressure, the surface is depressed still lower, so as to get below the level of the lower end of another tube, and so on; more of the tubes will become opened, one after another, as the pressure may require.



PROPELLING BLADES.

Gardiner Stow, late of King-street, Cheapside, now of New York, gentleman, for "*Improvements in apparatus for propelling ships and other vessels.*" (A communication.)—Granted January 11; Enrolled July 11, 1848.

In this invention an attempt is made to combine the screw-propeller with the paddle-wheel. The propeller, though placed at the sides of the vessel, like the paddle-wheel, is formed on the screw principle. Its form consists of a series of curved blades, set at an angle of 45° with the propeller-shaft, which is placed parallel with the vessel's course, similar to the ordinary screw-propeller; but instead of being submerged, it is sustained by bearings projecting from the vessel's sides (there being one on each side of the vessel), at such a height from the line of flotation, that simply the curved blade, or about one-seventh of the whole diameter, will be immersed. These curved blades are severally portions of a screw, and are supported from the shaft by radial arms, being further strengthened by stays extending in the direction of the length of the shaft. These propeller-shafts are each furnished with bevelled wheels, which gear into corresponding wheels on the main or engine-shaft lying across the vessel, as the ordinary paddle-shaft. As these propellers are caused to rotate, the curved blades will be successively brought into contact with the water, one end thereof entering first, the concurrent angle propelling the vessel onwards, and as it leaves the water, the next blade in succession will be immersed, maintaining a continuous and uninterrupted propelling power.

MARINE STEAM-BOILERS.

Thomas, Earl of Dundonald, Vice-Admiral in Her Majesty's Navy, for "*Improvements in marine steam-boilers, and apparatus connected therewith.*"—Granted February 11; Enrolled August 11, 1848;

The principal features of this invention are the application to marine-boilers of the principle adopted for consuming the smoke in other boiler-furnaces, by admitting a stream of hot air behind the bridge, to burn the gaseous products, and the removal of the steam-chest from the top of the boiler to the end of it, thereby lessening the height. His lordship claims seven separate parts, which may be thus briefly noticed. Firstly:—The more perfect combustion of the gaseous products at their entrance into a tube-chamber, constructed according to a former patent granted to him, by combining a stream of undecomposed hot air with such products. Secondly, the constructing boilers with the steam-reservoir placed below the level of the water in the boiler in lieu of the steam-chest as usually constructed above the boiler. Thirdly, the drying of the steam by its being exposed to a portion of the fire-place, or by passing the flue or chimney through it. He claims, Fourthly, a mode of preventing the priming of steam-boilers by means of a plate or separator placed within the boiler, the end being below the surface of the water in the boiler. Fifthly, the right of making and using a spiral or centrifugal separator; which, however, may be made square or other shape, and still retain the principle of the invention—namely, the separation of the water from the steam, and the mode of carrying off such separated water back to the boiler, without being obstructed by a contrary current of steam, by means of a pipe or channel from such spiral separator to the boiler. Sixthly, he claims a mode of working the propellers of steam-vessels by means of short propeller-shafts. And, lastly, a mode of constructing boat-boilers and apparatus.

VALVES AND PLUGS.

John Frederick Bateman, of Manchester, for "*certain improvements in valves or plugs for the passage of water or other fluids.*"—Granted January 18; Enrolled July 18, 1848.

The chief object of this invention is to make a valve suitable for the water-pipes, the valve being made of smaller specific gravity than water, and being opened by being forced down by a plug. The claims of the patentee will sufficiently explain the structure of the valve. He claims, first, the application for the passage of water and other liquids, of a globular valve, of a lighter specific gravity than water, constructed of a coating of vulcanised india-rubber, gutta percha, or other suitable elastic substance, so that the valve shall be closed by the pressure of the liquid. Secondly, the use and application of a globular valve of the same or a greater specific gravity than the fluid, constructed with a coating of vulcanised india-rubber or other elastic substance, so that the valve shall be closed without the aid of machinery, by the pressure of the liquid. Thirdly, the opening of the valve against the pressure of the liquid, by means of a plug or key, through which the liquid will flow from the valve, the plug or key being attached to the fixed part, without the aid of any screw or thread.

PREPARATION OF BAR-IRON.

William Russell, of Lydbrook, Gloucestershire, iron-master, for "*an improvement in the preparation of such bar-iron as is used in the manufacture of certain kinds of rod-iron.*"—Granted January 29; Enrolled July 29, 1848.

This invention may be very briefly described. The object is to remove from the surface of ordinary bar-iron the spill or scale, which is found to be very injurious in making the billets from which wire-rod-iron and horse-shoe-nail rod-iron are manufactured. The scale is removed by passing the bar-iron through a kind of draw-plate called a "cleanser," composed of grooves formed in the shape of the letter "V." In conducting the operation, the iron is first made into lumps of about one hundredweight and a quarter. It is then removed to the hammer, where it is reduced by hammering to short bars of five or six inches square. It is next passed through the rolls in the usual manner, and reduced to bars of about one inch and a quarter square. In passing through the two last and finishing grooves in the rolls, opposite which the cleanser is placed, the lower half is slightly lowered in order to admit of the entrance of the bar to the rolls which draw the bar through. During this finishing operation, pressure is exerted to bring up the cleanser by means of the lever and shaft, thereby scraping the iron on all its four sides, and effectually removing all the spill and scale from the surface. The bar is then passed over the upper roll, and is introduced through a smaller groove in the rolls, when the operation of scraping is repeated, as before.

THE GRESHAM PROFESSORSHIP.

We have seen with great regret the decision as to the Professorship of Geometry in Gresham College, because it is an indication of a return to the old system, which it was held forth should be abandoned, and the College restored to its former efficiency and rank in the scientific world. A decision more lamentable than that now made could hardly have been come to, for it is a total abnegation of scientific attainment and exertion as a qualification for the Professorship.

Among the candidates were Professor Moseley, the Rev. Morgan Cowie, Mr. Potts, the Rev. Pelham Dale, and Mr. Edkin.

Professor Moseley took high honours in mathematics at Cambridge, is the author of a work on the "Mechanical Principles of Engineering," and is a professor in King's College, London.

The Rev. Morgan Cowie took higher honours, and was the senior wrangler of his year. He was afterwards elected Fellow of St. John's College, and Moderator of the Examinations in the University of Cambridge. He now holds the appointment of Principal in the College for Civil Engineers.

Mr. Potts and the Rev. Pelham Dale have devoted themselves to mathematical studies, and have published papers on scientific subjects.

Mr. Edkin took a low degree at Cambridge, and has since been a teacher in the City of London School.

The Gresham Committee have appointed Mr. Edkin to the vacant Professorship.

It is not attempted to be put forward that Mr. Edkin is entitled on the ground of his scientific superiority, but he is said to have given satisfaction as a master in the School. It may be added, that he is related to an influential member of the Common-Council

It may happen, albeit Mr. Edkin has as yet given no proof of his competency, that he may make as good a professor as Mr. Moseley or Mr. Cowie; but whether he do or not, the appointment is equally unjustifiable.

These professorships are not simply appointments of men competent to discharge the duties, but they are rewards for previous exertion; and when properly awarded, their beneficial influence is great, because, as all candidates must comply with the condition of having given practical and public proofs of competency and distinction, a powerful stimulus is given to the industry of those who are enterprising, and there is a curb on the indolent.

In University College, the way in which the appointments are made is very simple. A committee is appointed, not of members of the Council, but of the professors of the faculty in question, who draw up a report, stating the education of the candidate, the honours he has taken, the appointments he has held, the works he has published and the character of them, and the unpublished MSS., illustrative of his studies and researches, which he has submitted to them. Thus all the materials for coming to an impartial decision as to the merits of the candidates are laid before the Council, and their appointment is made in accordance with the report. There can, therefore, by this system, be no canvassing and no jobbery.

The Trustees of Gresham College have not adopted any such course, and they have not even the poor and usual plea of favouring a member of their own College, because their College has no *alumni*.

The appointment resolves itself into the gross breach of a public trust, and it is necessary that measures should be taken to prevent its recurrence. The University of London has no legal jurisdiction in this case, but it has a moral interest in seeing justice done; and we recommend that a memorial should be addressed to the senate, and another to the Committee of Council on Education, praying that they will take measures to obtain relief. These memorials should be signed numerously by literary, scientific, and professional men, and by citizens of London, and they may result in some better system for the future. It will be easy for the University of London to provide for the examination of future candidates, leaving the appointments to the Trustees, who will thus be put under a moral and public responsibility, to which they are not now subjected.

If Gresham College were properly administered, how useful might it be to the younger professional men and mechanics of the metropolis. The Chair of Geometry, once held by Briggs and Wren, ought not to be without a competent successor; and by giving an evening course of proper lectures, great benefits would be conferred, and the very serious want of mathematical instruction in some degree be supplied. Those who know the good that has been done by Lord Brougham's Evening Classes for Schoolmasters, at University College, would earnestly wish the system of cheap evening instruction to be extended. As a recent example of the way in which these classes work, we may mention that a school has been opened in the Mechanic's Institution, under the direction of one of these graduates, and in which the children of members are taught at fourpence per week.

Those who advocate literary institutions for the working-classes have been seriously impressed by the evident consequences of giving desultory instruction, which prevails in such places, and which has the tendency of unsettling rather than of strengthening the minds of young men; but no measures have been taken to establish colleges or institutions in which, for a guinea a-year, one or two lectures shall be given, in regular courses, on the higher branches of education in the faculties usually known as wits and philosophy. This can be done and ought to be done.

NOTES OF THE MONTH.

The Ordnance Maps are now undergoing the process of being electrotyped; they are to be sold at the low price of 2s. per sheet, or 6d. per quarter-sheet, and are to be issued as they are electrotyped, quarterly. The first series has just been published, and comprises part of Middlesex, Kent Surrey, Sussex, Lancashire, and Cheshire.

The Metropolitan Sewers Act has passed the House of Commons, and is now in the Lords. The purport of the Act is to embrace into one Commission all the Commissions in Middlesex, Surrey, and Kent, excepting the City and the Regent's-park Commission;—why the latter is to be omitted, we are at a loss to conceive. The measure, which we long ago advocated, will be incomplete if that division be not included, as the district runs right through and bisects the Westminster division. It has a sewer of ample capacity and depth to drain all the upper division of the old Westminster Commission. It commences near Primrose-hill, passes through the vicinity of Regent's-park, Portland-place, Regent-street, and Charing-cross, and discharges its contents in the Thames near Whitehall and Scotland-yard. If transverse sewers be formed in the New-road, Oxford-street, and Piccadilly, nearly the whole of the Borough of Marylebone and Westminster may be drained into it, without any great expense being incurred. We trust it is not too late to introduce that Commission into the Act. The district of the new Commission is to extend to the distance of 12 miles in a straight line from St. Paul's Cathedral. We do not like the idea of the Commission being empowered to make their own bye-laws as to penalties—this is very objectionable, to say the least of it.

Payne's Process for rendering Wood Fireproof.—On Wednesday, August 2, an experiment was exhibited at Whitehall-wharf, Westminster, for testing Mr. Payne's patent process for rendering wood fireproof, and for showing that his wood-preserving process is as effectual for the preservation of wood from destruction by fire as from the ravages of insects, dry-rot, &c. Two small houses were constructed, one of ordinary deals well dried, and the other of deals prepared by Mr. Payne's process, and each filled with fire-wood and shavings. Both were kindled at the same time. The house composed of the unprotected wood caught fire very soon, and in about half an hour was completely consumed: while the Payneized house remained standing nearly as perfect as ever,—the fire in it having gone out of itself, and left only some slight marks of charring on the inside of the boards. The liquid employed by Mr. Payne (by preference) is sulphuret of barium or calcium.

The Conversion of Diamond into Coke.—Professor Faraday lately gave a lecture on this subject at the Royal Institution, in consequence of M. Jacquelain having, in the course of last year, succeeded in converting diamond into a substance possessing the appearance, physical character, and electrical properties of coke by the following process:—Having attached a piece of hard gas-retort carbon to the positive wire of Bunsen's battery of 100 elements, he placed on it a small piece of diamond. He then armed the negative wire with a cone of the same carbon, and, by dexterous manipulation, enveloped the diamond with electric flame. After a short interval, the diamond underwent a sort of ebullition, became disintegrated, softened, and was actual coke. (*Comptes Rendus*, June 14, 1847; *An. de Chimie*, tom. xx., p. 459).—On this experiment Prof. Faraday made the following observations. 1. *As to the property possessed by certain substances to assume totally different forms without undergoing any chemical change.* The Professor adverted to the case of sulphur, which becomes brittle when suddenly cooled from its first state of fusion, but is soft and pliable when similarly cooled from its second state of fusion.—2. *As to the source of heat employed.* Professor Faraday dwelt on the beauty and power of the voltaic arc as a furnace, showing by experiment that diamond could be burned into carbonic acid gas by means of a current of oxygen gas directed on it when highly heated. The Professor stated that neither this heat nor any short of that of the voltaic battery, except that of the solar lens, was sufficient to convert diamond into coke. The fusion of rock crystal by a current of oxygen sent through an ether flame was noticed; and it was shown that this powerful heat was inferior in intensity to that of the battery.—3. *The condition of the diamond when thus converted into coke.* It becomes absolutely lighter. The spec. gr. of ordinary diamond is 3·368;—when changed into coke its spec. gr. is 2·679. It loses its insulating power. Professor Faraday here alluded to some experiments by M. Karsten *Archives des Sciences*, 1847), proving that certain compound bodies were conductors or not according to their preparation. He stated that this was the only case analogous to carbon.—4. *As to the philosophy of the change of the diamond's structure.* Referring to M. Gassiot's demonstration that the heat is greatest at the positive pole of the battery, Professor Faraday suggested the possibility that the particles of diamond might, under the influence of the intense heat, tend to form vapour having a sensible and assisting expansive force, and that in their axial position as regarded the enveloping discharge they might assume a state having relation to a diamagnetic condition. He requested to be understood, however, as offering this idea merely as a philosophical conjecture. Finally, he referred to Graham's supposition, that the difference between diamond and coke might depend on their known difference of specific heat.——In reference to the above experiments of M. Jacquelain, on the conversion of diamond into coke, Mr. Nasmyth states, in a communication to the *Mining Journal*, that he "had long since discovered that *coke was diamond*, in as far as that coke is possessed of one of the most *useful* and remarkable properties of diamond in respect to its power of *cutting* glass—owing, doubtless, to the extreme hardness of its ultimate particles, or minute crystals of which a mass of coke is formed. We are apt to consider coke as a soft substance, because we can crush it, and pulverise it with facility; but if we examine into the actual hardness of the minute, plate-formed crystals, which compose a mass of that substance, we shall find that they are possessed of a most remarkable degree of hardness, and can *cut* glass with that clean-looking cut which is so peculiar to the diamond." He feels certain, that when the extreme diamond-like hardness of coke is made known, that the fact will be laid hold of, and turned to good account as a most cheap material for all grinding purposes, such as required for many processes in the arts—to say nothing of its useful application to the sharpening of a razor, as a very superior strop powder; for which purpose, however, the coke must be reduced by *evigation* to the most minute and impalpable powder.

Dover Refuge Harbour.—This great national work is progressing with much spirit, and begins to show what it will be. The first portion, 800 feet of a massive sea-wall, has been contracted for by Messrs. Lee of London; and the works are carried on under the superintendence of their agent, Mr. Scott. The plan is that of Mr. James Walker, the eminent engineer; and the execution of the engineering department also devolves on him and his partner, Mr. Burgess. The works now extend 130 feet into the sea, and the curve to the eastward has been commenced. One diving-bell was lately put into requisition in the process of levelling the rocks for the foundation, and another will be speedily brought into use. Of the immense quantity of stone (8,500 tons) which has been landed here within a few months, nearly one-half has already been put down. The blocks are uniformly of large dimensions, some exceeding 10 tons weight.

Sunderland Docks.—The extensive works now in progress for the formation of the new docks at Sunderland are proceeding in the most rapid and successful manner. The sea has been most effectively banked out of the tidal basin, and nearly the whole length of the large dock; and there is the fullest confidence that this gigantic undertaking will be brought to a successful completion within the time fixed; and, what is still more unusual, there is a well-grounded expectation that it will be finished considerably within the estimated cost. The works begin to have a noble appearance, and when finished will be a magnificent undertaking. A dock of this magnitude, gained from the sea within the range of the tides, is an enterprise now proved to be practicable, and a safe undertaking.

Blasting Rocks.—The *Plymouth Times* observes: "The vast improvement effected in the mode of blasting limestone rock in this port, within the last 37 years, is almost surpassing belief. Last week, with a charge of 1 cwt. of powder, placed in a hole in the rock, 18 feet deep, no less than 1,000 tons of limestone rock were blasted at one blast, and that, too, without any accident occurring to the man engaged in firing the rock. He was six hours engaged in the operation, and was seven times pulled up from the side of the hole to the top of the quarries, before the fire took effect, and this huge blast was made."

Opening of Railways.—The Chester and Holyhead Railway was, with the exception of 3½ miles adjoining the Menai Straits, opened on Tuesday, August 1st., throughout, for goods and passenger traffic.—The Leeds, Dewsbury, and Manchester Railway, lessening the distance between the former and latter town 10 miles, was opened for public traffic on the 4th of August.—The opening of the Rouen and Dieppe line took place on Saturday, July 29.—The Castlecary branch of the Caledonian Railway was opened for public traffic on Monday, August 7, thus completing the direct line between London, Perth, Dundee, Arbroath, and Montrose. The express train from Dundee arrived at the Euston-square terminus in 15 hours, and from Arbroath in 15¾ hours.

A New Turn-Table has been invented by Mr. Turiff, of the Vulcan Foundry, Paisley. An engine and tender, weighing 36 tons, placed on one of the turn-tables, can be turned by two men by means of two wheel-pulleys, with comparative ease, in about a minute and a half, without any jar. The great advantage of this invention of Mr. Turiff's is, that with former turn-tables there were two frictions, while with this table there is only one; it is relieved by a powerful weight resting on the centre, which contains four large bolts, that lift the table from the side rails beneath. The machinery is very simple, composed of massive beams of iron, and can be worked by circular rollers, in cases of emergency. The turn-table itself is 36 feet in diameter, weighs 25 tons, and sustains 51 tons revolving weight.

Indurated Gypsum.—It is known that calcined gypsum, after being moistened with a solution of alum and again burnt, acquires much greater hardness and solidity. M. Kreating recommends for the same purpose a solution of 1 lb. of borax in 9 lb. of water, which is poured over the calcined fragments of gypsum. They are then kept at a strong red heat for six hours, ground to a powder and worked. The effect is said to be still better if a pound of tartar and twice the quantity of water are added to the solution.—*Liebig's Annalen.*

Suspension-bridge at Niagara Falls.—The *Albany Journal* states that the foot-bridge at the Falls was to be ready for crossing on the 4th of July:—"It consists of 16 cables; the number of strands in each cable, 600; ultimate tension, 6,500 tons; capacity of the bridge, 500 tons; number of strands in the ferry cable, 37; diameter of the cable, ⅞ths of an inch; height of stone tower, 68 ft. 1 in.; height of wood tower for ferry, 50 feet; base of tower, 20 square feet; size at the top, 11 square feet; span of the bridge, 800 feet; whole weight of the bridge, 650 tons; height from the water, 230 feet; depth of water under the bridge, 250 feet. This suspension-bridge is the most sublime work of art on the continent. It makes the head dizzy to look at it, and yet it is traversed with as much security as any other bridge of the same width. We were present while the workmen were engaged in hanging the planks over the fearful chasm. It looked like a work of peril, but it was prosecuted with entire safety. Not an accident has happened since the first cord was carried across the river at the tail of a kite. It is impossible to give the reader a clear idea of the grandeur of the work. Imagine a foot-bridge 800 feet in length, hung in the air, at the height of 230 feet, over a vast body of water rushing through a narrow gorge at the rate of 30 miles an hour. If you are below it, it looks like a strip of paper suspended by a cobweb."

Nature's Gas Works.—"An immense volume of natural gas, sufficient for the supply of a city, was discovered a few days since, near Detroit, Michigan, by the Messrs. Granger, while boring a 4-inch shaft for water. At a depth of 70 feet they struck a vein or cavity, from which issued a violent current of air, which threw up stones as large as hens' eggs, 10 or 15 feet high, accompanied by a volume of water, rising 10 or 12 feet. On applying a light to the air, it burnt furiously, the flame rising 20 feet. It is proposed to conduct this gas in pipes to Detroit, and light that city with it."—*New York Sun.* [Very much like a romance.]

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM JULY 20, TO AUGUST 22, 1848.

Six Months allowed for Enrolment, unless otherwise expressed.

Chevalier Alexandre Edouard le Molt, of Conduit-street, Middlesex, for certain "Improvements in apparatus for lighting by electricity, parts of which may be made use of in other applications of electricity."—Sealed July 20.

David Napier, and James Murdoch Napier, of York-road, Lambeth, engineers, for "Improvements in mariner's compasses, also in barometers, and in certain other measuring instruments."—July 20.

William Thomas, of Cheapside, London, merchant, for "Improvements in the manufacture of stays, boots, and shoes, also in fastening and connecting fabrics and garments."—July 26.

John King, foreman to Messrs. Shears and Sons, Bankside, and Henry Medhurst, operative engineer to the said Messrs. Shears and Sons, for "Improvements in gas meters."—July 26.

Charles Hancock, of Brompton, Middlesex, gentleman, for "Improvements in apparatus or machinery for giving shape and configuration to plastic substances."—July 29.

John Grist, of the New North-road, Middlesex, engineer, for "Improvements in furnaces and fire-places."—July 29.

James Robertson, of Great Howard-street, Liverpool, Lancashire, cooper, for "Improvements in the manufacture of casks and other wooden vessels, and in machinery for cutting wood for those purposes."—July 29.

George Walter Pratt, of the city of Rochester, state of New York, in the United States of America, gentleman, for "Improvements in the manufacture of printing-ink."—July 29.

Richard Abbey, of Slough, Buckingham, brewer, for "Improvements in preserving fermented and other liquids and matters in vessels."—July 29.

Edward Gribben Wilson, of Bury, Lancashire, tin-plate worker, for "certain Improvements in the construction of tin drums or rollers used in the machinery for drawing, spinning, dowling, twisting, and throwing cotton, wool, silk, flax, and other fibrous substances."—August 1.

Duncan Mackenzie, of Goodman's Fields, manufacturer, for "certain Improvements in Jacquard machinery for figuring fabrics and tissues generally, and apparatus for transmission of designs to said Jacquard machinery, parts of which are applicable to playing musical instruments, composing printing types, and other like purposes." (A communication.)—August 5.

David Newton, of Macclesfield, Chester, merchant, for "certain Improvements in the application of glass and glazed surfaces to nautical, architectural, and other similar purposes."—August 7.

Samuel Thornton, of Birmingham, merchant, and James Edward M'Connell, of Wolverton, Buckinghamshire, engineer, for "Improvements in steam-engines, and in the means of retarding engines and carriages on railways, and in connecting railway carriages or wagons together; also improvements in effecting a communication between one part of a railway train and another, by signals or otherwise."—August 7.

John Medcalfe, of Little Bolton, Lancaster, machine maker, and Robert Halliwell, of the same place, mechanic, for "certain machinery or apparatus for preparing and spinning cotton and other fibrous substances."—August 8.

Moses Poole, of London, gentleman, for "Improvements in the manufacture of casks and other similar vessels of wood." (A communication.)—August 8.

Samuel Lees, of the firm of Hannah Lees and Sons, of Park-bridge, Lancaster, iron-manufacturer, for "certain Improvements in the manufacture of malleable iron."—August 8.

Joshua Couch, of Harleston, Northamptonshire, agricultural implement maker, for "Improvements in sackholders."—August 10.

William Thomas Henley, of Clerkenwell, philosophical instrument-maker, and David George Foster, of Clerkenwell, aforesaid, metal merchant, for "certain Improvements in telegraphic communication, and in apparatus connected therewith, parts of which improvements are also applicable to the moving of other machines and machinery."—August 10.

Samuel George Hewitt, of Buchanan-street, Glasgow, N.B., engineer, for "Improvements in the construction of certain parts of railways."—August 11.

John Varley, of Bury, Lancaster, engineer, for "certain Improvements in steam-engines."—August 14.

James Henderson, of Surrey Canal Dock, millwright, for "Improvements in machinery for cleansing and polishing rice, pearl barley, and other grain and seed."—August 14.

Joseph Simpson, of Manchester, civil engineer, and James Alfred Shipton, of the same place, engineer, for "certain improvements in steam-engines."—August 14.

Edwin Thomas Truman, of the Haymarket, London, dentist, for an "Improved method methods of constructing and fixing artificial teeth and gums; and of supplying deficiencies in the mouth."—August 15.

James Warren, of Montague-terrace, Mile-end-road, Middlesex, gentleman, and Willoughby Theobald Monzani, of St. James's-terrace, Blue Anchor-road, Bermondsey, gentleman, for "Improvements in the construction of bridges, aqueducts, and roofings."—August 15.

Thomas Delarue, of Bunhill-row, Middlesex, manufacturer, for "Improvements in producing ornamental surfaces to paper and other substances."—August 15.

William Galloway and John Galloway, of Knott-Mill Iron-Works, Hulme, in th borough of Manchester, and county of Lancashire, engineers, for "certain Improvements in steam-engines."—August 17.

Moses Haym Picciotto, of Finsbury-square, London, merchant, for "a method or methods of purifying and decolorising certain gums."—August 17.

Thomas Richardson, of Newcastle-upon-Tyne, chemist, for "Improvements in the condensation of metallic fumes, and in the manufacture of white lead."—August 21.

William Young, of Queen-street, Cheapside, lamp manufacturer, for "Improvements in closing spirit and other cans or vessels."—August 21.

Isaac Taylor, of Stanford Rivers, Essex, gentleman, for "Improvements in preparing and engraving surfaces, also in the construction of cylinders adapted for engraving, and also in machinery for printing and ornamenting surfaces."—August 21.

Richard Shaw, of Gold's Green, West Bromwich, in the county of Stafford, railway-bar finisher, for "Improvements in the manufacture of iron into tyre-bars, round-bars, square-bars, and flat-bars, T-iron, angle-iron, and trough-iron."—August 21.

John Bethell, of Parliament-street, Westminster, gentleman, for "Improvements in preserving animal and vegetable substances, and also stone, chalk, and plaster, from decay."—August 21.

Alexander Angus Croll, of the Gas works, Tottenham, for "Improvements in the manufacture of gas, and in apparatus to be used in transmitting gas."—August 22.

Alonzo Buonaparte Woodcock, of Manchester, for "Improvements in steam-engines, and in apparatus for raising, forcing, and conveying water and other fluids."—August 22.

STEAM PILE-DRIVER.

(With an Engraving, Plate XII.)

Patented by Mr. James Nasmyth, *and Manufactured by* Messrs. Nasmyth, Gaskell, and Co, *of the Bridgewater Foundry, Patricroft, near Manchester.*

Public works are acquiring such magnitude even in their details, and their several parts are so numerous, that they are constantly making greater requirements on the resources of mechanical engineering. It has been a matter of dispute frequently whether a particular class of works belonged to the architect or the civil engineer; and Professor Hosking goes the length of claiming the whole domain of civil engineering as belonging to architecture. Others may now come forward and claim many of these works as the province of mechanical engineering. Thus, a still greater tendency to the separation of the professions of the architect and engineer is created. The tubular bridges over the Conway and the Menai, the High Level Bridge at Newcastle, iron and screw pile lighthouses, and suspension-bridges, are more the production of the mechanical engineer than of the architect. As a specimen, we gave in our August number an account of the ingenious patent Jacquard machine, invented by Mr. Roberts, for punching the plates of the tubular bridge at Conway, for the purpose of saving time and labour; and in our present number we publish the engravings of another powerful machine, invented by Mr. James Nasmyth, for driving piles by the aid of steam, and which has been used with great success in the construction of the High Level Bridge at Newcastle, the Docks at Plymouth, and other works of magnitude. It is gratifying to see this mutual aid of civil and mechanical engineering, for it is this combination of talent which is best calculated to elevate the character of both branches of the profession, and to extend their application. Whatever mechanical processes diminish the cost of production, whether of a railway or of a pin, contribute to increased use; and we look forward to a great reduction in railway expenditure from the progress of improvement, and consequently to an extension of the system under circumstances where, from considerations of economy, its application is not now contemplated.

Any consideration of the great works of civil engineering, even in such a case as the Eddystone Lighthouse, will show how much depends on overcoming the mechanical obstacles which stand in the way. Time is money, and money again often saves time; and a due attention to these points enables an engineer to execute his works cheaply and well. At the present time, a great deal depends upon the rapid and economical prosecution of works, and it becomes doubly important to call in the aid of mechanical science wherever, as in the cases already named, it promises to do the work more efficiently and more economically.

The merits of the steam pile-driver now before us consist, in the first place, in the direct manner in which the elastic force of steam is employed as the agent by which the "monkey" (or block of iron which strikes the head of the pile) is lifted to the height requisite for that purpose. Secondly, in the very peculiar and original manner in which the pile itself is made to act as the only support for the active or blow-giving portion of the apparatus; by which arrangement, the entire dead weight of the apparatus in question is turned to most important account as a "*persuader*," to assist the pile in sinking into the ground when in the act of being driven: this dead weight also acting very importantly as an anti-recoil agent, so far as its entire weight (three tons) can accomplish that object.—Thirdly, in the peculiar manner in which the pile-driving part of the apparatus is permitted to sink down along with the pile, and guide it in its descent, so as to remove all chance of the pile twisting, or in any respect swerving from the true position given to it at the commencement of the operation of driving.—Fourthly, in the peculiar manner in which a vast increased degree of energy is given to the blows of the monkey beyond that which is due to the height through which it falls.

The engraving exhibits an arrangement of the "Patent Steam Pile-Driver," for driving two piles in two continuous lines, without the necessity of a previously-existing gangway, the machine making its own way as it is moved forward. Fig. 1 is a side elevation; fig. 2, a section on *a b*; fig. 3, front elevation; fig, 4 a plan, showing the engine and platform; fig. 5, a plan of the timbers which carry the platform and saws; and figs. 6 and 7, enlarged views of the steam-cylinder and driving-hammer.

The apparatus and machinery consist of the following parts:—

Firstly, the steam-boiler, A, similar to a locomotive-boiler, with steam-chest on the top. This boiler stands upon a platform B, supported on iron wheels b, running on iron rails b^1, placed on balks of timber b^2, fixed on to the top of the piles as they are driven; and vertical guide-posts C C, with pulleys, $c\,c$, $c^1\,c^1$, on the top.

Secondly, a small steam-engine D, placed horizontally in the centre of the platform, with connecting-rod d, driving a crank d^1, and pinion d^2, on the crank-shaft, that takes into a cog-wheel e, fixed on one end of a shaft E, with pinion e^1 on the other end that takes into another cog-wheel f, fixed on the long shaft F, upon which are fixed two pinion-wheels f^1, f^1, that take into cog-wheels $f^2\,f^2$, fixed on the axles of two spiral-fluted barrels $f^3\,f^3$, upon which are coiled the chains $f^4\,f^4$, for lifting the steam-pile, driving-cylinder, and hammer. Upon the ends of the shaft D, are two smaller barrels G, for the ropes or chains g^1 to lift the piles into their places.

Thirdly, the pile-driving apparatus, consisting of a cylinder H, with its piston-rod passing out at the bottom, and directly attached to a block of iron or monkey I (weighing about 35 cwt.), placed inside of a square wrought-iron case J, which acts as a guide to the hammer in its rising or falling, and rests upon the shoulder of the pile K at $j\,j$; and at the same time, grasps the neck and shoulders of the pile with great tightness, so that it cannot twist or swerve from the position which the vertical guide-posts C give to the case J, and which is clamped to the posts by the sliding-clamps $j^1\,j^1$. L, L, are steam-pipes from the top of the boiler A, to the pile-driving cylinder H, jointed together by swivel joints of cast-iron.

Fourthly, horizontal saws M, M, fixed on to the underside of the platform, for cutting off, to a level surface, the heads of the piles as they are driven. The saws are worked by the bevel gearing m, fixed on to the middle shaft, E.

With respect to the action of this machine, in order to describe it with clearness, we shall suppose that the pile-driving part of the apparatus seen in fig. 1, and enlarged view figs. 6 and 7, marked H, I, J, has been wound up by the small engine D, and the gearing F, and let down upon the shoulders of the pile K, and the steam admitted under the piston in the cylinder H, by means of the jointed wrought-iron pipes L, L, L, which serve to convey the steam from the boiler A to the cylinder H, at whatsoever height the cylinder may be at in respect to the boiler. The steam being let in under the piston, the steam-hammer action is commenced, and the 35-cwt. block I, is made to give 75 to 80 blows per minute with a fall of 3 feet, upon the head of the pile, with such earnest energy as to cause the pile to sink into the soil at an average rate of from 5 to 10 feet per minute (according to the nature of the soil). As each blow is given, the apparatus H, I, J, follows down along with the pile, as the shoulders of the pile are the only means of support to H, I, J, and they are therefore free to slide down the face of the vertical pole C, the instant a blow is given to the pile-head and drives it down; and this action is so rapid, that the eye can scarcely appreciate the interval. The jointed steam-pipe at the same time accomodates itself to every new position which the sinking pile causes the driving-apparatus to assume. For the purpose of opening and closing the steam-valve, there is a small inclined plane on the hammer-block, inside the case, which coming in contact with the end of a small lever passing through an opening in the side of the case J, shown in figs. 6 and 7, causes the valve in the valve-box (cast on the steam-cylinder H) to open and shut. When the steam has raised the piston to its proper height, the steam-valve, by the action of this lever, is closed, and an outlet-valve opened, which allows the steam to blow out into the air and the hammer-block to descend.

As soon as the pile is driven to the required depth, the apparatus is again wound up by the small engine D; and the next following pile K^1, which may have been in the mean time hoisted by the engine D and gearing G, ready for driving (as seen in fig. 1), is then "pitched" or placed in its proper situation. The locomotive gear is then put in motion, and the apparatus lowered down on to the shoulders of the pile in question. The hoisting-chain f^4, is then let free, so that the apparatus may be free to rest on the shoulders of the pile, and follow down along with it as before. The steam is now again let into the cylinder H, and the driving proceeded with as before. The ease and dispatch with which the entire process is proceed with requires to be seen to be duly appreciated. Piles have been driven by this machine into descriptions of soils and under circumstancen which would have put all the attempts of the ordinary pile-driving machines at utter defiance.

It may be proper to observe, that notwithstanding the energetic blows which this maehine showers down on the heads of the piles, in consequence of these blows being given by so massive a hammer as 35 cwt., and at the moderate velocity acquired by a fall of only

3 feet, they do not the slightest damage to the pile-head: so much is this the case, that the pile-heads have actually a neater appearance *after* being driven than before.

In respect to the means employed for giving to the blow of the monkey a greater degree of energy than such as would be due to its fall through 3 feet, this object is accomplished by having the top of the cylinder H made air-tight, and by having a set of openings at *h*. The instant the piston passes these openings in its upward action, all further motion in that direction is terminated by the compression of the air then confined in the space between the top of the piston and under-side of the cylinder cover; which compressed air, on recoiling, adds to the force of the blow all the energy it would have acquired by falling from the height to which the monkey would have been carried by the momentum given to it in the upward direction by the lifting action of the steam acting on the under-side of the piston.

We have much pleasure in appending to our description a copy of a certificate by Mr. Stephenson.

"Nasmyth's Steam Pile-Driving Machine has for some time past been employed in piling the foundations of the High Level Bridge at Newcastle-upon-Tyne, and at the Viaduct over the river Tweed, near Berwick. Its operation has been triumphantly successful. Piles have been driven with great economy and remarkable dispatch, where the ordinary methods would have entirely failed.

"I consider this machine to be one of the most valuable and important auxiliaries which have recently been invented for the construction of engineering works.

ROBERT STEPHENSON.

24, *Great George-street*, *Westminster*,
May 2, 1848."

CANDIDUS'S NOTE-BOOK,
FASCICULUS LXXXVI.

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. The lately-opened Catholic Cathedral of St. George's does not say very much for Mr. Pugin's artistic talent and taste. Satisfactory as are many of the separate parts and ornaments when considered merely by themselves, just as articles of furniture are looked at and examined in a show-room where they are exposed for sale,—they are there brought together without any regard to artistic keeping and effect. The consequence of which is, they do not serve to set each other off to advantage; but, on the contrary, there is much that is quite at variance with all the rest. We see a collection of studies of various ornamental details, and other mere *matérial* of design, but we miss a well-studied and consistent whole. The most opposite and conflicting sorts of architectural character are brought into contact with each other. Barn and ball-room are strangely mixed-up together. In the chancel, and the two chapels at that end of the church, decoration is not only carried to such extent as to cause all the rest to look unusually cold and bare, but fails to produce the amount of richness aimed at. When added up, the total does not answer to the value of the several items as taken by themselves.

II. In architecture, incapacity for producing new ideas shelters itself under the plausible pretence of a reverential regard for old ones. Because excellent ideas have been produced before our time, we are told that we have no occasion for any of our own. Aught that partakes of innovation is set down as both unorthodox and dangerous; which is assuredly most comfortable doctrine—highly convenient, and therefore comfortable, because merely to copy is easy and safe; whereas, to attempt to emulate is a difficult as well as a doubtful matter. We do well, therefore, to protest against innovation—that is, for ourselves, since those whom we profess to look up to and admire, were in their day very gross innovators: by gross, I mean wholesale innovators. The history of the art shows a series of innovations from first to last; that "last"—finale and conclusion of it as a creative art, seems to have been already reached; and all that is now left for us is merely to repeat, perchance to mimic, what has been done before. Whatever may be the case with the twentieth, the nineteenth century will not shine in the history of architecture; or if it is to do so, it must now set about it in earnest, for half its time is already gone. Bad or good, the Elizabethan period had a distinct architectural character of its own; whereas, the present Victorian one has none, but is "everything by turns," of most chamelion quality, but without any distinct, self-acquired, character. The present age is content with merely making use of those hoards of art which its more industrious predecessors wrought out and accumulated. Satisfied with being able to live upon the interest, we do not seek to improve the capital. In fact, to such a pass has architecture been brought, that further progress for it in any direction is impossible, so long as we persist in our present perverse views of it—of its nature and powers as a fine art. No matter what style we take up, we treat and are expected to treat it literally—to adhere to it servilely, instead of being allowed to infuse any fresh ideas into it, or even, by varying its *tournure*, to adapt it to greatly-altered purposes and occasions. Provided the separate features and details be but correctly copied from those in former buildings, we are quite satisfied, though the structure so compounded be full of incongruities as a whole,—prosaic and unartistic.

III. One consequence of the present rage for the merest copyism is, that we ourselves produce no structures that will deserve to be studied hereafter as original models and architectural records of the age in which they were erected. Even our most monumental edifices will not be monuments of our own time,—of our own ideas moulding and organising the fabrics we rear. Future antiquaries will be greatly puzzled some centuries hence, to determine dates from the styles which buildings exhibit. At any rate, they will set down this nineteenth century as that in which architectural talent displayed itself chiefly in mimicry and masquerade. This is what is not particularly pleasant to contemplate, though it is what we have to thank the present race of antiquaries for, and others whose opinions and influence as employers control the free-agency of architects, who, whatever they might have done by timely resistance to such domineering dictation, can hardly help themselves now. They have suffered their necks to be put into the yoke; so, however hard it may be to bear, they must now endure it with what patience they can. All that we can look forward to, is to its being shaken off by some bold and independent spirit, gifted not with genius only, but with the opportunity of manifesting it decidedly, however it may run counter to the minikin theory and doctrine of established rules. But as miracles are not to be looked for and calculated upon like the return of comets, we cannot with any sort of reason look forward to such event. Nay, instead of being looked forward to with anxious hope, even the possibility of its occurring is contemplated with real apprehension by many, who accordingly deprecate most earnestly what they are pleased to call "tampering" with existing styles. Incapable of forming a valid judgment, they take refuge in prejudice. By their croaking cry of "rash"—"absurd"—"extravagant"—"chimerical!" they endeavour to intimidate; and by denouncing before-hand all aim at originality, and every deviation from ordinary custom and rule, seek to insure the accomplishment of their ill-omened predictions. The merely aiming at it does not insure success in achieving originality; but if, instead of being aimed at, it is sedulously shunned, it will never be achieved by any one; and were there no possibility of failing, there would be no particular honour gained by succeeding. Many act most discreetly in not attempting to signalise themselves and their works at all by any unborrowed ideas—by which are to be understood not mere fancies for which they can assign no sufficient reason even to themselves, much less to any one else, but ideas that have germinated, have been meditated upon and matured, in their own minds. In not attempting or affecting to do what they are conscious lies far beyond their power of reach, such persons manifest their prudence; it is, on the contrary, only dogmatical presumption, when measuring the powers and abilities of others by their own, they pronounce that which is to themselves impossible to be equally impossible to every one and all. Rather ought they, if at all sincere in the regard they profess for the interests of architecture and its advancement, to welcome the doctrine of its being possible to enlarge the present boundaries of the art almost indefinitely. How far he as an individual can contribute to such progress and amplification, must be left to each individual to decide for himself. Those who feel no impulse from within, may be left to jog on as they can *secundum artem*—that is, ploddingly and mechanically: but they have no right to prescribe the same limits to others. As matters are managed at present, a prohibition is actually laid upon original genius, it being demanded of it that it should forego its very nature, and exercise itself only in the same track of ideas as has been previously trodden: in other words, it must conform to routine. A good deal has been argued about the Emancipation of Woman; I wish somebody besides myself, and of far greater authority and influence, would stand up boldly for the Emancipation of the Architect, who is at present fettered by prejudices—in reality the merest cobwebs, but twisted together till they become as bulky as cables. If my views and opinions are erroneous, let them be opposed; yet no one it seems cares either to oppose or to second me. Well! if I am not flattered, even by contradiction, neither am I discouraged. Happy are those who expect nothing, for they shall not be disappointed; and that state of beatitude is mine.

II. As it is now too late to protest against the barbarism of stripping the Quadrant of its colonnades—and they have assuredly contributed not a little to the architectural character of Regent-street, the Quadrant being by far the most scenic part of the whole line,—let us hope that the columns themselves will be preserved, that is, re-erected, so as to form some ornamental structure elsewhere,—on some spot where they will not give any *umbrage* to shops and shop-keepers—and the latter show themselves to be somewhat unreasonable, because it was they who came to the colonnades, and not the colonnades to them. Their removal would be less matter of regret, were we but assured that the columns would now be so applied, that ample amends would be made to us for what we shall lose in Regent-street. If no better and more utilitarian purpose can be suggested for them, they might be employed to form an open screen of two lines of columns, inclosing the court-yard in front of the British Museum. Sir Robert Smirke's building itself would gain materially thereby, inasmuch as it would be seen from the street very picturesquely through the range of Doric columns in front, which being, besides, on a lesser scale, would serve to give greater importance to the Ionic colonnades behind. To the very excellent suggestion here volunteered, it will be objected—and objections are always as cheap as suggestions themselves—that the Quadrant columns are only Roman-Doric, while the façade of the Museum is pure Greek-Ionic. That ultra-Grecianism is affected for it, is not to be denied; but there is even now a great deal in the general design that is anything but pure Greek in physiognomy. Neither the wings, with their homely and ordinary house look, nor the two little bits between them and the main building, would be able to reproach the Quadrant columns with being too undignified and unclassical to bear them company. Still, one thing may be confidently predicted: I therefore prophecy that my idea will not be adopted, nor even so much as taken into consideration. Happy the prophet whose predictions are sure to be verified, and such state of beatitude, I repeat, is mine.

THE NATIONAL GALLERY.

Whatever general truth there may be in the paragraph which appeared in last month's *Art-Journal*, informing us that the present National Gallery is to undergo extensive alteration by Mr. Barry, its correctness as to particulars may be questioned. What seems to vouch for such piece of intelligence being more than a mere vague, unauthorised report, is the express statement of the sum to be expended—viz. £50,000; to which the architect is to be limited. And for that the entire façade is to be altered, and another story added to the building. How the latter can be accomplished without destroying the lantern lights in all the rooms now constituting the upper-floor, puzzles both ourselves and others to conceive. There appears to be no other alternative or mode of alteration in that case, than that of lighting the present rooms from their sides, or rather their two ends, in the front and back of the building; which would hardly be any improvement as far as they are concerned, nor perhaps much, if any at all, to the exterior.

It has all along been the *fashion*—we can call it nothing else—to decry and abuse the National Gallery, more especially its façade, as if that were not merely the chief, but the sole disfigurement of Trafalgar-square,—as if St. Martin's Church, and the other buildings on the east and west sides of the "Square," were absolute paragons of architectural taste and excellence. Even those who affect excessive admiration for the "Church," affect to be scandalised at Wilkins's façade of the "Gallery." Ask them, *why?* and they soar upwards—fly into a towering passion,—and from that altitude, look down upon you with scorn most supreme. Even that lump of architectural cockneyism and dulness, the "College of Physicians and Union Club-house," if it does not obtain admiration, at least escapes censure, which is levelled exclusively against that scape-goat of Trafalgar-square, the National Gallery. However, the latter is to become a "Deformed Transformed;" and poor St. Martin will need the whole of his cloak to spread over and shelter the insignificance of his Church.

As to one material point connected with the purposed alteration we are left in entire doubt, not being informed whether the whole of the additional story is to be appropriated to the "Gallery," or the portion of it at the east-end of the plan, bestowed upon the Royal Academy.

Whatever may be done to it, the building can never, in our opinion, be rendered adequate to the now greatly-increased, and henceforth likely to become still greater, requirements for the national collection of pictures, unless the whole of it be given up to the "Gallery," and the Academy turned out to provide for itself elsewhere. For exhibition rooms, the Academy needs only longitudinal extent of plan at the rear of a very moderate-sized front towards the street, for the walls being invariably covered from top to bottom with pictures, the rooms themselves might be of the very plainest description,—both in construction and appearance not at all superior to ordinary show-rooms, auction-rooms, and similar places. Therefore, if the space now required for the "Gallery" demands it, we should say, turn the Academy adrift to shift for itself. It does not throw open its doors gratuitously to the public: why then should it expect to be in any way supported by the public,—or, what is just the same thing, by government? At any rate, there is no necessity for the Academy's continuing to occupy so considerable a portion as it does of the building in Trafalgar-square, now that the whole of it is required for the national collection of pictures.

The paragraph in the *Art-Journal* does not speak at all doubtingly, as of rumour that requires confirmation; therefore, unless it should be contradicted, we may presume that there really exists a definite intention of enlarging and otherwise altering Wilkins's edifice; and that, consequently, government do not entertain any idea of erecting a new National Gallery, as has been talked of by many, and by some fully expected. There have been various rumours on the subject, one of them being that a structure for the pupose was to be built upon the inclosed area in Leicester-square. In what is now stated, there is far more of probability and likelihood, although the *Art-Journal* speaks only upon a "we understand." Let it be based upon what it may, that "understanding" assumes some degree of shape and colour, several particulars being distinctly touched upon. Mr. Barry's design has been "submitted to the proper authorities," and not only approved of, but, as it would seem, actually determined upon before the public were aware that anything of the kind was in contemplation. It is not, indeed, very easy to reconcile this with what is said in another page of the same publication, where we are told that Mr. Pennethorne being directed to examine the lower rooms of the present Gallery, with a view to the Vernon Collection being deposited there, reported their total unfitness for such purpose, and recommended that a plain temporary building, calculated to last about a dozen years, should be erected, and that in the interim parliament should make an annual grant of from £15,000 to £20,000 for a permanent edifice. One tale contradicts the other: either Mr. Barry's design, or Mr. Pennethorne's suggestion, is thrown out. If there is to be a new building in some other situation, the present Gallery will remain untouched; and *vice versâ*, if the latter is to be greatly enlarged, and to have £50,000 expended upon it, another structure will not be erected. Between the two schemes lies doubt: error there is as to one of them, and error there may be as to both. Still, something appears to be in agitation or contemplation; therefore, it is not at all amiss that public attention should be directed to it at an early stage of proceedings.

Most may be of opinion, and some are or have been in full expectation, that let be done whatever might—whether a new National Gallery is to be built, or the present building enlarged, the work would, like the "Houses of Parliament," be made the subject of competition. The occasion itself is a public one, and of a kind to exercise talent in no ordinary degree; a structure for the purpose being something altogether *sui generis*. Of almost every other kind of buildings the examples and instances are so numerous, that general conventional ideas may be taken from them; but with respect to Picture Galleries the case is quite different. For them there are no models; neither have any studies been provided, or aught of any moment on the subject been written and published. Some of the most celebrated public collections of pictures in Europe are in buildings which, besides being tasteless or in exceedingly bad taste themselves, are so badly arranged and devoid of all contrivance, that they do not seem to have ever been intended for the purpose to which they are applied. Besides accommodation with regard to actual space, effective lighting the rooms, and other obvious matters of that kind, the providing for a judicious arrangement of the pictures is what requires considerable study and foresight. In temporary exhibitions, pictures must be hung up as well as they can be. The disposing them on the walls is of necessity a work of such hurry, that it is little to be wondered at if it is frequently attended with awkward mistakes, such as putting a good painting nearly out of sight, and an inferior one just upon the line. Even if it be detected, there is no time for correcting the error, because to do so might render it necessary to alter the situations of a score of other pictures.

In a permanent gallery, on the contrary, more especially one claiming to be considered a public museum of art, where nothing, it is to presumed, is admitted but what is worthy of being studied—at least, of being noticed as a work of art,—the utmost attention ought to be given before-hand to what is required by the collection itself. Should this last be already fully formed, to provide properly for it becomes a comparatively easy task; whereas, for one that is increasing, regard should be had to future growth. When Mr. Wilkins—or rather, perhaps, those who employed him—took measure of it, our national collection was merely in its infancy. Thanks to Mr. Vernon, the child has nearly all at once started up into a tall stripling,—has quite outgrown his former "fit," which suit suits him no longer; so Mr. Barry is now it seems to enlarge it, and convert it as well as he can into a becoming *toga virilis*. If he can do so without reclaiming from the Academy the piece of stuff they have got possession of, he must have far more talent in point of contrivance than most of his professional brethren.

After all, we may possibly have been put quite on a wrong scent. Should which turn out to be the case, all we can say is, that the mistake does not lie at our door. We leave those from whom we got it to trace out the author of it; nor should we be greatly surprised to find it traced home—if mistake it really be—to that confounded, universal mischief-maker, Mr. Nobody!

COLLISION OF TRAINS.—No. II.

In our last paper (p. 197), we considered the law and amount of collision in a train of carriages of equal weights, and provided with a single engine in front. We now propose to examine the effect of an engine behind, the other circumstances of the problem remaining the same.

As a first and introductory example, let us suppose a single carriage, weight 4 tons, having a pair of buffers in front, with a foot play to each, and each with an extreme strength of 4 tons (the law of resistance of the buffers being assumed to vary as their compression), to impinge on a fixed obstacle with a velocity of 60 feet per second. Let us now determine how much of this velocity will be destroyed by the time the buffers have ceased to act.

Let m be the mass of the carriage; p, the pressure on the head of either buffer when it is compressed to an extent x; v, the velocity, in seconds, of the carriage;—then, the mass of the buffer being neglected as small in comparison with the mass of the carriage,

$$m v \frac{dv}{dx} = -2p.$$

Now, 4 tons is the value of p when $x = 1$; and since p has been assumed to vary as x

$$p = 4x; \quad \therefore m v \frac{dv}{dx} = -8x; \quad \therefore m v^2 = c - 8x^2.$$

If the accelerating force of gravity be taken at 32 feet per second,

$$m = \frac{4}{32} = \frac{1}{8}; \quad \frac{v^2}{8} = c - 8x^2; \quad v^2 = 8c - 64x^2.$$

$$\text{When } x = 0, v = 60; \quad \therefore 8c = 3600.$$

When $x = 1$, the buffers cease to act, and $v^2 = 3600 - 64$; or, $v = 59\frac{1}{2}$ nearly; consequently, only half-a-foot of velocity is destroyed.

Let us next consider the case of a train of n carriages, each provided with a pair of buffers before and behind; and with an engine, weight r tons, attached to the last carriage; and let us suppose this train to impinge on a fixed obstacle at the rate of V feet per second; and from these data seek approximately the amount of velocity destroyed in the rearward engine by the time all the buffers are used up.

In order to make the problem general, we will assume the weight of the carriages each $= w$, and the extreme strength of the buffers μh tons; also their extreme play h feet. By the time the engine behind has moved forward a space x, after collision has commenced, let $2p$ be the pressure on the buffers of the rearward engine. We shall now show that p is always less than $\frac{P}{n'}$, where n' is the number of pairs of buffers, and P the pressure on any buffer compressed to an extent x. For let x_1, x_2, x_3, &c., be the extent to which the buffers are simultaneously compressed, reckoning from the carriage which first sustains the shock; μx_1, μx_2, μx_3, &c., the pressures of the buffer-heads corresponding to the compressions x_1, x_2, x_3, &c. Now we have shown in our last paper that the pressures of the buffers, and therefore x_1, x_2, x_3, &c., decrease as we recede from the end of the train nearest collision.

$$\therefore x_1 \text{ is} > x_2; \quad x_2 \text{ is} > x_3; \quad \text{\&c. is} > \text{\&c.}$$

$$p = \mu x_{n'}; \quad p \text{ is} < \mu x_{n'-1}; \quad p \text{ is} < \mu x_{n'-2}; \quad \text{\&c. is} < \text{\&c.}$$

$$\therefore n'p \text{ is} < \mu (x_{n'} + x_{n'-1} + \text{\&c.}) \text{ is} < \mu x \quad \text{is} < \text{P};$$

$$\therefore p \text{ is} < \frac{\text{P}}{n'}.$$

$$\therefore \int_{n'h}^{0} p\,dx \quad \text{is} < \int_{n'h}^{0} \frac{\text{P}}{n'} dx \quad \text{is} < \int_{n'h}^{0} \frac{\mu x\,dx}{n'} \quad \text{is} < \frac{\mu n' h^2}{2}.$$

Therefore, if v be the velocity of the rearward engine, by the time the buffers are all used up,

$$\frac{r}{32} (\text{V}^2 - v^2) \text{ is} < 2 \mu n' h^2.$$

As an example, let $h = 1$, as before; $n = 19$; $\therefore n' = 40$ (including buffers of engines before and behind); $r = 20$; $\text{V} = 60$; $\mu = 4$.

$$\therefore \text{V}^2 - v^2 \text{ is} < \frac{32}{20} \times 320 \quad \text{is} < 32 \times 16 \quad \text{is} < 512.$$

If $\text{V} = 60$, $\therefore v^2$ is > 3088; $\therefore v$ is > 55. Or, the velocity of the rearward engine has been diminished by less than 5 feet a second.

If V had been put $= 30$, which is equivalent to about 20 miles an hour, still v would have had a value of 20 feet a second, or twelve miles an hour. In either case, it is clear that the shock of the engine behind would have been most destructive—in the first case frightfully so.

To recapitulate the results of our investigation, it appears, first, that when a train with a single engine is violently checked, the first carriage will sustain the greatest damage, and the effect of the buffers will be to increase the number of blows on the first and succeeding carriages, but to diminish their intensity. Secondly, that when an engine is attached behind; the last carriage after all the buffers are used up—having first to sustain the shock of the rearward engine proceeding with a diminished but still considerable velocity, if the original velocity of the train had been great,—will probably be the most seriously injured of all the carriages. A double shock will in this case have passed along the train—at first, by the sudden stoppage of the first carriages *before all* the buffers are used up; and then from the blow from the rearward engine *after all* the buffers are used up.

Since writing the former paper on this subject, we have seen a model of a break, by Mr. Bishop, which by an ingenious and simple contrivance is capable of being applied to all the carriages simultaneously, and almost instantaneously. We earnestly recommend the adoption of some such method of suddenly occasioning a powerful retarding force, as a most efficient means of avoiding casualties and coroners' inquests.

J. H. R.

NOTES ON ENGINEERING.—No. XI.

By Homersham Cox, B.A.

The Strength of Hungerford Bridge.

The security of a Suspension Bridge erected in the very centre of the metropolis, and liable to sustain the weight of a very large number of persons, is a subject possessing a scientific interest commensurate with its practical importance. The moment of the question has been greatly increased by two independent circumstances—first, that it has been the subject of serious doubt and scientific discussion; and secondly, that the traffic of the bridge has recently received an important accession by the opening of a railway terminus in its immediate vicinity.

There are some parts of the theory of suspension bridges exceedingly complicated and difficult, and others perfectly simple. Among the latter is the estimation of the statical strain to which a chain is subjected when its weight and all its dimensions are known. This particular branch of the question may be set at rest without much difficulty. The object of the present paper is to do this by methods distinct from those which have been adopted in the previous discussions of the question.

Sir Howard Douglas, who first publicly moved the subject of the sufficiency of Hungerford Bridge, has ably calculated the strength of the chains, on the assumption that the form of them is the "common catenary:" this method, the most scientific and exact of any, involves however considerable mathematical skill in its application. The mode about to be employed may be readily used in general practice, as it does not require a knowledge of mathematics; and the agreement of its result with that obtained by the process referred to, tends to their mutual confirmation.

In suspension bridges, the central deflection is always small compared with the span between the points of suspension. It follows that the curvature of the chain is very small; and whether it be considered a catenary, a parabola, or even the arc of a circle, the deviation from the real form will not be considerable. It is very usual, for the sake of simplicity, to assume the curve to be a parabola, and that assumption will be here adopted after a few remarks tending to prove its accuracy.

If the horizontal distribution of the weight of the chain and its load were uniform, the curve would be *exactly* a parabola, as may be easily ascertained by reference to any standard treatise on mechanics which refers to the subject. Now, when the bridge is crowded, the load on the platform *is* uniformly distributed horizontally. This is also the case with the weights of the platform and the parapet, which are considerable. The only mass not so distributed is that of the chains themselves, of which the links are horizontal at the centre, and inclined more and more up to the points of suspension. But practically this inclination is never large; for instance, in Hungerford Bridge at the points of suspension, as will be presently shown, the tangent of the angle of inclination is about $\frac{5}{17}$. This gives the cosine of the angle less than $\frac{18}{17}$; or 18 feet measured along the chain there, nearly corresponds with 17 feet measured horizontally. This shows that the hypothesis of horizontal distribution, even for the chain alone, does not involve any considerable error; and when the additional effect of the mass of the load and platform, which is really so distributed, is taken with it, the deviation from the truth must be inconsiderable.

On this assumption, then, the vertical line through the centre of gravity of half the chain and its load is situated midway between the centre of the chain and the extremity of the platform; or the horizontal distance of this centre of gravity from the abutment is equal to one-fourth the span. Therefore, the moment about the point of suspension of the weight of half the chain and load, is the product of that weight and one-fourth the span.

At the centre of the chain the tension is horizontal: its vertical distance below the point of suspension is equal to the deflection of the chain. Therefore, the moment of this tension about the point of suspension is the product of the tension and the deflection.

The moments just determined are equal, the total effect to turn the half-chain about the point of suspension being produced by the weight, and this effect being resisted by the effect of the horizontal tension. (The platform not being rigid, contributes nothing to the ultimate support of the load.) Also, in Hungerford Suspension Bridge, the deflection is 50 feet, and the quarter-span 169 feet. Consequently,

Horizontal tension × 50 = *weight of half-span* × 169.

Hence the weight of the half-span is $\frac{50}{169}$, or very nearly five-seventeenths of the tension at the centre of the chain.

On the authority of Mr. Cowper, who is believed to have obtained authentic and accurate information, it is stated, in Part 93 of this *Journal* (June, 1845), that the total sectional area of the chains at their centre is 296 square inches. The Bridge is supported by four chains, two on each side of the platform, and the above is the sum of the sectional area of all four together. The horizontal tension is supposed to be uniformly distributed over these 296 inches.

Wrought-iron bars become sensibly stretched and impaired when subject to a tension of 17 tons per square inch. They will not bear that strain permanently; and in practice it is not considered safe to subject them to a greater tensile force than 9 tons per square inch. Taking the latter measure, the greatest horizontal tension which the four chains together can safely bear is 296 × 9 = 2664 tons; and the greatest weight of the half-span must, by what has already been said, be $\frac{50}{169}$ths of this, or very nearly 788 tons. Consequently, for the whole-span,

The greatest total load = 1576 *tons*.

This is, in fact, nearly the load to which the bridge is actually liable to be subjected. The weight of the chains (715 tons) added to that of the platform, parapet, rods, &c., and a crowd covering the platform with a weight of 100 lb. to the square foot, gives, according to Mr. Cowper, the maximum load at about fifteen hundred tons. We come to the conclusion, then, that when the bridge has its full load, the statical tension at its centre is nine tons to the square inch.

The following method was adopted to test the accuracy of the hypothesis on which this conclusion is founded. By a known principle which applies to catenaries of every form, the tangents at any two points of the curve meet in the vertical line through the centre of gravity of the intervening portion of the chain. Consequently, if the assumption be true that the vertical through the centre of gravity of the half-chain bisects the half-span, the tangent at the point of suspension ought, if produced, to meet the platform midway between its centre and extremity. The observation of this fact would be a *crucial* test of the above conclusions. This test was satisfactorily performed in the following manner. The inclination of the chain at its summit was observed with a telescope from various positions on the Bridge, and that position was noted in which the inclination of the chain at its highest point coincided with the axis of the telescope. That position of the observer's eye for which one end of the highest link *covered* the link, was of course in the line of that link produced. By these means (applied for the sake of mutual confirmation to the points of suspension at both towers), it was ascertained that the centre of gravity of each half-chain was about six feet nearer the end, than the centre, of the platform. The advantage of this method of observation was, that it did not require particular accuracy: an error of 10 or even 20 feet would not have made a considerable difference in the result, while the errors of observation were certainly far within those limits.

It is important to observe, that if the Bridge were loaded with its full weight, the actual position of the centre of gravity would coincide with that above assumed, even more closely than it did at the time of the observation.

To ascertain the tension at the points of suspension, we have the following rule, applicable to catenaries of every form. Add the squares of the horizontal tension and of the weight on the half-span: the square root of this sum is the tension at the summits of the chain—which, therefore, in the case before us, is

$$= \sqrt{\{(2664)^2 + (778)^2\}} \text{ tons.}$$

After obtaining this square root, divide it by 9, and the result is 308, for the number of square inches over which the tension at the summit must be distributed if the tension be 9 tons per square inch. The actual sectional area of the chain at the points in question is very near this—namely, 312 square inches.

In the above caculations, the structure has been supposed to be in a state of equilibrium. The vibrations of the several parts of the chain, arising from the rapid motion of traffic, or the action of the wind, would certainly increase the strains greatly, though no means of calculating that increase have been yet ascertained. The foregoing method shows, with all the precision requisite for practical purposes, that both at the centre and extremities of the chain the tension of the metal is 9 tons per square inch, when the bridge is fully loaded. The fairest way of stating the conclusion from these investigations appears to be this:—If the permanent tenacity of the metal be so great that it may be safely subjected to a greater strain than 9 tons per square inch, then the excess is a provision against accidental disturbances. If, however, 9 tons per square inch be the utmost strain which the metal will safely bear, no margin is left for security against the effects of rapid motion.

THE WATER-GAS.

Some time has elapsed since a patent was obtained for a process of making illuminating gas from water; but the plan was not carried into practical effect, and dropped out of public notice. The invention has once more been brought before the public, and in a manner calculated to attract attention, by being made the subject of lectures delivered by Mr. Ryan at the Polytechnic Institution. The process itself is a very curious one; and though the expense may probably render it a less economical mode of supplying gas than coals, where they are to be purchased at a cheap rate, yet, in many parts of the country, it is probable that the water-gas may be the cheaper of the two; and as its purity and illuminating power exceed those of the carburetted hydrogen obtained from coals, it is well that the mode of making it should be generally known.

To those who are unacquainted with the chemical composition of water, it may seem strange that water should be rendered the source of fire; but to most of our readers it must be well known that water is composed of hydrogen, the most inflammable of bodies, and of oxygen, which, when in the form of gas, is the most active supporter of combustion. A plan of obtaining hydrogen gas from water, by passing steam through a hot tube containing iron has been long known. The *rationale* of that process is, that the steam when in contact with heated iron becomes decomposed, the oxygen uniting with the iron to form an oxide of that metal, and the hydrogen is liberated in the form of gas. This, indeed, is the best mode of obtaining hydrogen gas in a state of purity; but for the purpose of illumination, such gas is of no value. The flame, though emitting great heat, is scarcely visible. The illuminating power of coal-gas depends on the carbon it contains; and the more carbon is contained in carburetted hydrogen, the greater is its illuminating power. It is owing to the great proportion of carbon in turpentine, that it affords such a brilliant light in the "camphine" lamps, the only difficulty in the burning of that substance being to produce perfect combustion; otherwise the abundance of carbon causes volumes of dense smoke. To render the water-gas illuminating, it is necessary, therefore, to combine with it a portion of carbon; and it is this part of the process in which the principal novelty of the invention consists. The apparatus employed in the manufacture of the gas is exhibited at work at the Polytechnic Institution. It consists of a furnace, in which are three long iron retorts placed perpendicularly. Two of these are nearly filled with coke and old iron chains, or pieces of iron. Water is admitted into the first of these, and being converted into steam, it is then decomposed by the iron, and the hydrogen gas which is liberated, absorbs at the same time some portion of carbon from the heated coke. The gas and residual steam are then passed into the second retort, where a similar process of decomposition and of further carbonization takes place; and it then issues into the third retort, where it is brought into contact with heated tar, and absorbs from it a large portion of carbon. The carburetted gas is then forced through some vertical tubes, to permit the deposition of superfluous tar, and is conducted into the gasometer ready for use. The illuminating power of this gas is estimated to exceed that of ordinary coal-gas, 25 per cent.; and its freedom from sulphur and other impurities renders it far preferable to coal-gas. Respecting the economy of the process, Dr. Ryan says nothing; and we believe that it was on this point that the invention failed to be practically useful when first introduced. The cost of the fuel to heat the retorts, of the iron to decompose the steam, and of the tar to carbonise the gas would, we fear, amount to more than the cost of coal, in most parts of England, for making the ordinary kind of coal-gas. In many circumstances, however, we conceive this mode of generating illuminating gas may be advantageous, especially when the purity of the gas consumed is an object of importance.

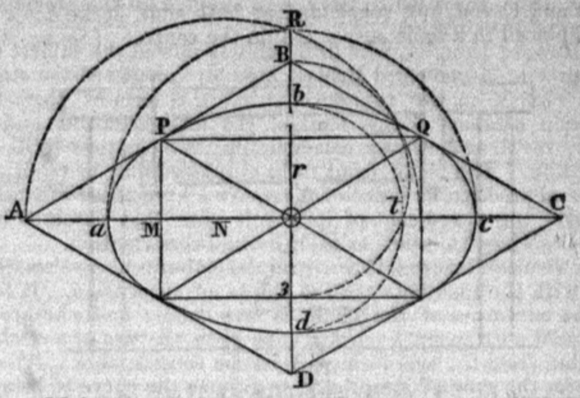
ON ISOMETRICAL PERSPECTIVE.

By R. G. Clark.

The object of this article is to communicate an easy method, by construction, for determining the transverse and conjugate diameters of an ellipse touching the sides of an oblique parallelogram, being the isometrical projection of a circle inscribed in a square.

Draw the isometrical parallelogram A B C D, and its two diagonals A C, and B D; bisect O C in *m*, also bisect A *m* in N, and then with the radius A N and centre N, describe a semicircle cutting O B, produced in R. Again, with centre O, radius O R, describe a semicircle *a* R *c* cutting A C in *a* and *c*; then will *a c* be the transverse diameter required of the ellipse. In like manner, bisect O D in *s*, and B *s* in *r*, and with the centre *r*, and radius *r* B, describe a semicircle cutting O C in *t*; again, with centre O and radius O *t*, describe an arc cutting D B in *b* and *d*, then will *b d* be the conjugate diameter required.

The above may be demonstrated thus:—Because the sides of the oblique parallelogram respectively touch the curve, they are tangents to it. By the properties of the Conic Sections (see Dr. Hymer's elegant treatise), we have, $AO \times MO = aO^2$; but $MO = mO$, therefore $aO^2 = AO \times mO$. Also, by the property of the Circle, we have $aO^2 = OR^2$. A similar mode of proof applies to the conjugate diameter. After the diameters are thus determined, the curve can be easily trammelled in the usual way. It would also be well to state an easy rule, by calculation, founded on the above construction.



Rule.—Multiply the diameter of the circle by 1·224 for the transverse diameter, and by ·707 for the conjugate diameter.

Ex.—Given the diameter of a circular turn-table = 14′ 5″, to find the transverse and conjugate diameters of its isometrical representation.

Here, by the rule, 14·5 × 1·224 = 17·748 transverse diameter.
14·5 × ·707 = 10·25 conjugate diameter.

The previous method of construction, however simple, I have not before met with in any work on isometrical perspective. The rule by calculation is easily deduced from the construction, making the isometrical diameter, or the given diameter, of the circle equal to unity: Thus, because the isometrical angle $OAB = 30°$, therefore $BO = \frac{1}{2} AC$. Hence $OA = \sqrt{(1\cdot - \cdot 25)} = \cdot 866$; therefore, $aO^2 = AO \times MO = \cdot 866 \times \cdot 433 = \cdot 3749$. By extracting the square root of each side, we have $aO = \cdot 612$; consequently, the transverse diameter $ac = 1\cdot 224$. Also, $BO = \frac{1}{2} BC = \cdot 5$; therefore, $BO \times \frac{1}{2} BO = bO^2$; hence $bO = \cdot 3535$; consequently, the conjugate diameter $bd = \cdot 707$. These are the numbers as given in the rule. I have not seen this rule in Jopling's treatise, but there is a table given of diameters, with the same figures to the Diameter 1. It will be observed, that all the lines that are in the figure are not required in the construction, but only the two diagonals: the other lines are only drawn to assist in the demonstration. The method given by Professor Farish in his paper on *Isometrical Perspective*, in Gregory's "Mathematics for Practical Men," is very tedious, both by construction and calculation.

EXPERIMENTS ON CEMENT.

A good deal of attention has recently been directed to the merits of a cement called "Portland" cement, manufactured by Messrs. Aspden and Robins, of Northfleet; and on Monday, the 18th ult., a numerous body of architects, builders, &c., assembled at the town premises of these gentlemen, in Great Scotland-yard, to witness a number of experiments with the cement, both alone and in combination with sand, in different proportions; the following are some of the trials made:—

Best Stock Bricks Cemented against the Wall.

Experiment 1.—17 stock bricks were cemented together with *roman cement* (all cement) and projected before the face of a wall, as fig. 1. They broke down with 7 lb. placed on the end.

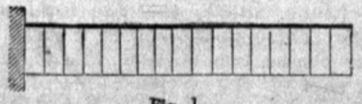


Fig. 1.

Experiment 2.—11 stock bricks, cemented together with 1 sand and 1 roman cement, broke down with 7 lb. placed on the end.

Experiment 3.—38 bricks, cemented with neat, patent *portland cement*, broke down with 14 lb. placed on the end.

Experiment 4.—30 bricks, cemented together with 1 portland cement and 1 sand, broke down with 15 lb. at end.

Experiment 5.—22 bricks cemented together with 1 portland cement and 2 sand, broke down with 168 lb. at end.

Experiment 6.—25 bricks, with 1 portland cement and 4 sand, broke down with 56 lb. at end.

Experiment 7.—26 bricks, with 1 portland cement and 5 sand, broke down with 74 lb. at end.

Experiment 8.—14 bricks, all portland cement, with a wheel of 9 cwt. in the centre, broke down with 17 lb. at end.

Experiment 9.—16 bricks, cemented together with 1 portland cement and 1 sand, and suspended at both ends, broke down with 15 cwt. placed in a scale suspended on the centre. (*See* fig. 2).

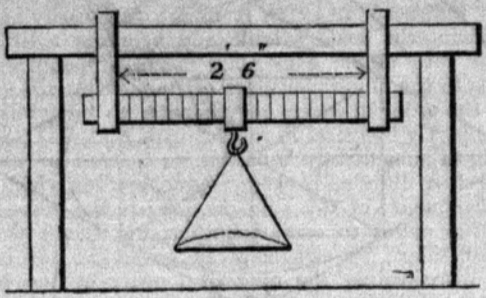


Fig. 2.

Experiment 10.—A block of portland stone, 2 ft. 11 in. long, and 9 by 9 inches, broke with a weight of 38 cwt. (*See* fig. 3.)

Note.—A block, cemented with roman cement, would not bear the weight of the stone, in a similar position.

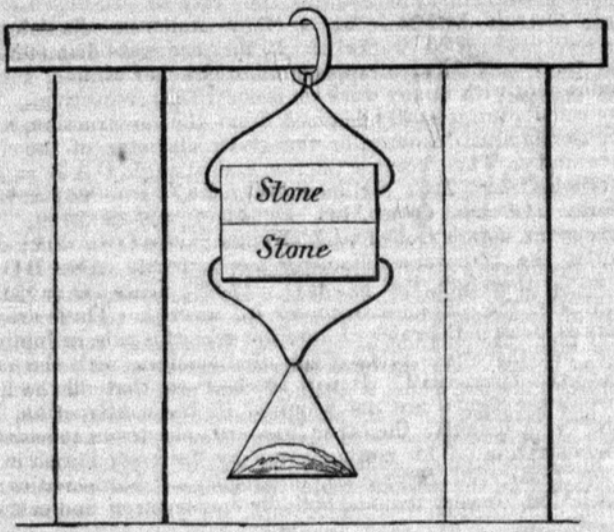


Fig. 3.

Trials in a Hydraulic Press.

Experiment 11.—A block, all portland cement, 18 inches high and 9 × 9 inches, bore a pressure equal to 108½ tons on the square foot.

Expt. 12.—A mixture, 1 sand and 1 cement, ... 80 tons sq. foot.
Expt. 13.—A mixture, 4 „ 1 „ ... 80 „ „
Expt. 14.—A mixture, 7 „ 1 „ ... 44½ „ „

Experiment 15.—A block, all roman cement, broke at 22½ tons.

Experiment 16.—A mixture, 4 parts sand and 1 roman cement, would not bear any pressure.

Experiment 17.—A block of portland stone, 1½ in. × 1 in., broke up at 23 cwt.

Experiment 18.—A block of the portland cement, the same dimensions, broke with 18 tons.

New Screw-Cutting Machine.—A plan of cutting iron screws is stated to have been invented by Mr. P. H. Gates, of Chicago, Illinois, by which the power of one man will cut per day, 700 half-inch, 500 three-quarter inch, 400 one inch, and 300 one-and-a-half inch bolts. The advantages claimed for this plan over the common die are, its dispatch in doing work; its durability, having cut over 4,000 bolts with one die, without any repairs; instead of jambing or driving the thread into shape it cuts it out, the same as in a lathe, leaving the thread of solid iron, which cannot be stripped off as is usual with those cut by the common die, and it will do the work by once passing along the bolt, making the thread perfect. The die, it is said, can be made by ordinary workmen, with far less expense than the common die, and when made, is not at all liable to get out of repair.

REVIEWS.

The Palace of Westminster. Imperial quarto, Part I. London: Warrington and Son, 1848.

At present, we can hardly pretend to give an opinion as to the merits of a series of architectural illustrations from the three engravings in this first Part; nor are we able even so much as to say to what extent it is intended to carry the publication, and what will be the entire number of plates, there being neither prospectus nor advertisement on the wrapper to afford that somewhat desirable information. What strikes at the very first as objectionable is, not that the plates are published miscellaneously while the work is coming out, but that it seems they are intended to be bound up so, instead of being duly arranged according to some sort of order and sequence. The subjects contained in this Part I. are: Plan of the Principal Floor, the Royal Court (a perspective view), and an Elevation of the lower part of the Victoria Tower, which are designated in the heading of the descriptive letter-press accompanying each of them, as Plate I., II., III., respectively. Wherefore, although the descriptive letter-press itself is not paged—which looks as if it had been intended to leave it to purchasers to arrange the subjects ultimately to their own fancy—such accommodation is now frustrated by the plates being numbered in the letter-press, and in our opinion quite uselessly, there being no corresponding numbers on the plates themselves, so that the binder can be guided only by their titles. We almost fancy that the "numbering" must have occurred through mere oversight; and if so, now that the very great inconvenience attending it is pointed out, it ought to be abandoned at once,—should which be done, cancels ought to be given of the descriptions already published.

As matters have been managed, Plate I. is a Plan of the Principal Floor; but surely that will not be the only illustration of the kind, or else the work will be singularly defective and unsatisfactory. Hardly can we believe that it is not intended to give some other plans—at any rate that of the ground-floor, it being quite indispensable for properly understanding the structure. The floor immediately above the principal one ought also to be shown. Besides which, there are many portions of the Principal Floor itself which require to be exhibited upon a larger scale, and much more in detail; the scale of the general plan being no more than that of an inch to 120 feet, which is so small that it is imposible to measure from it with any sort of accuracy some of the lesser rooms;—wherefore it would not have been amiss had the respective dimensions, according to actual measurement, been inserted in the "Key to the Plan." With regard to the plan itself, it does not extend beyond Westminster Hall; consequently, it does not show what is to be done on the west side of the Hall, along Margaret-street and New Palace-yard. Nor is the plan quite so distinct as it might be, owing to all the parts that are under roof being shaded, and only the open courts and areas left plain or white. So far indeed distinction is made between the covered and uncovered parts of the plan, but there might just as well have been greater distinctness also produced by making the walls considerably darker than the rest. In our opinion, shading of the kind might have been dispensed with altogether in what is an upper-floor plan, it being quite sufficient to treat the ground-floor one in that manner. Or—for the disagreeable doubt now comes across us—is this plan to be the only illustration of the kind? We will not believe that it is until we can no longer disbelieve it. Even a ground-floor plan will not be quite satisfactory unless it be made to show—except that be done in a separate situation's-plan, on a lesser scale—the relative position of Westminster Bridge, Henry VII.'s Chapel, and other circumstances of the peculiar locality. Else, how are those who are quite unacquainted with that locality, to form any notion of it? A publication like the present, more especially its subject being taken into account, is not likely to be confined to this country, but will be eagerly turned to abroad, wherever the fame of the Palace of Westminster and its architect has reached; and how are those who possess no other information than what they can derive from plans, to understand the difficulties imposed upon the architect by the site, and make due allowance for what must strike them as being defective and unsatisfactory in the disposition of the west or principal land-side of the edifice? For our part we should say, that besides a general situation's-plan, there ought also to be a plan of all the buildings as they existed before the fire. And undoubtedly a plan of the kind ought to be inserted in this publication, if only as a historical document.

Plate II. shows, in a perspective view, a part of what is called the Royal Court, it being that into which the state carriage and other royal equipages drive and turn round when the sovereign goes to parliament. Here we see on the east side, the large bay window and range of upper windows of the Royal Gallery, and part of the south side of the court, where the windows on the principal floor belong to the office of the Lord Great Chamberlain. The archway through which the carriages pass from the porch beneath the Victoria Tower is quite in a corner, at the south-west angle of the court. The architecture of the court is good, but not at all remarkable, except on the west or gallery-side of it, where the two archways below (one of them leading into the Chancellor's Court) the small octagonal staircase turret, the oriel window with solid wall in the compartment between the buttresses on each side of it, broken only by arched and splayed panels, containing royal armonial bearings, form, together with the range of lofty windows above (those in the upper part of that side of the gallery), form a sufficiently picturesque and piquant combination,—such as can hardly fail to captivate the admirers of the olden time. What the other elevations of the court, which are not shown in the view, may be, the description does not inform us. To say the truth, the descriptive letter-press is exceedingly meagre, dry, and bald; and has, besides, the disadvantage of consisting only of detached scraps.

Plate III., the elevation of the royal portal or entrance-porch in the lower part of the Victoria Tower, exhibits, on a tolerably adequate scale, the exceedingly rich details of that part of the structure; in the character of whose open arch we fancy we recognise a resemblance to that of the beautiful Erpingham Gate at Norwich. Satisfactory as it is in other respects, the print hardly does justice to the structure itself; for it conveys no idea of the strikingly-fine effect produced by an open arch of such magnitude (50 feet high to its apex), on the exterior of a building. The plate being a mere outline one, the picturesque contrast of light and shade is quite lost; therefore, although it is not likely that any one will actually make such a mistake as to suppose that the arch itself is filled-up by the lesser arch and gate seen on the further plane of the elevation, it would have been better had that plane been entirely, though slightly, shaded—because then the opening of the arch would have been distinctly defined. There will, we hope, be a section of this porch drawn to the same scale as the elevation; and we also desiderate a fully detailed plan, to show the groining of its vault.

However interesting and excellent the materials for it furnished by Mr. Barry may be, the publication does not seem to have been planned with much judgment or foresight. The separate "History" of the Palace of Westminster is by Mr. H. T. Ryde; but who is the general editor, or who writes the descriptive portion of the letter-press is not said,—it is certainly nothing to boast of. As to what calls itself "Introduction," that might, in our opinion, very well have been spared, for it strikes us as being in wretchedly bad taste—a tissue of vulgar bombastic commonplace, and puff.

Since the above was put into the printer's hands, we have seen Part II., which came out only a very few days after Part I., and which gives us three more plates. The first of them exhibits to us in perspective a portion of the exterior—viz., the "South-Wing Towers" of the principal or east front; yet, although carefully done by a very competent architectural draughtsman (Mr. J. Johnson), and although we cannot but commend the diligence bestowed upon the drawing, the engraving is not altogether satisfactory. What has been alleged by some against the building itself, makes itself here felt; for the multiplicity of the details and enrichment spread over every part, is such as to occasion no small degree of confusion and indistinctness. This is especially the case with regard to the upper part—the towers and the roof, where the different forms and surfaces do not define themselves at all clearly. More decided general effect as to light and shade, and greater vigour of touch, are required. In fact, the ordinary mode of lithography—that here employed—is hardly capable of doing justice to such a subject, for it shows poor and flat in comparison with that improved method in which the *whites*, as they are technically termed, are printed; therefore, after being now accustomed to that more energetic and pictorial mode of lithography, we feel dissatisfied with the one here practised. With the next plate—the Interior of the Royal Porch—we are made to feel very much so; for whether it be that the impression we have got is a defective one, it is particularly feeble and tame, and most of all so in those parts which require some of the deepest touches of shadow. While there is little or no truth as to the general effect of light in such a situation, the shafts and mouldings of the second or smaller, immediately inclosing the third and smallest arch, are scarcely defined at all below, on the side which is in the shadow. It may also be objected that this subject shows us very little more than what is seen in Plate III. beyond the open arch in the elevation of the exterior of the porch, the view being confined merely to that east side, without showing anything of the vaulted roof, or of the flight of steps on the north side leading up to the royal entrance into the building; which is consequently not even so much as indicated, although it might very easily have been so by just reducing the scale a trifle, and bringing a little more of the interior into view. This plate moreover confirms what we have said as to the injudiciousness of numbering the subjects according to the order in which they happen to be published, since this view is partly identical in subject with Plate III., accordingly ought to have immediately followed it; instead of which, Plate IV. is altogether different in subject—one, besides, which interrupts the natural sequence of the subjects, for all the respective views of the exterior ought to come together, and follow each other in some regular order; yet no such arrangement can now be adopted, except by disregarding the numerical order of the plates, and thereby giving the letter-press the appearance of being strangely shuffled-up. Plate VI., however, does really follow Plate V. with great propriety; it showing on a larger scale the statues of the three popular Saints, Andrew, George, and Patrick, in the niches over the gate leading to the royal court. Whether they are worthy of having a plate devoted to them is a different matter: as mere architectural accessories, they may be privileged to pass muster without criticism; but if they challenge admiration on their own account as works of art, they are not likely to obtain it—at least, not as here represented, which is but in a very so-so-ish manner.

A General Sheet Table for Facilitating the Calculation of Earthworks for Railways, Canals, &c. By Francis Bashforth, M.A., Fellow of St. John's College, Cambridge.—Chain of 100 Feet.

Mr. Bashforth's previously-published table of earthworks was calculated to a chain of 66 feet. He has now extended the utility of his labours by calculating the present table for a chain of 100 feet: the method of applying the figures remaining the same as before. As we have already reviewed at length Mr. Bashforth's system, which is distinctly and peculiarly his own, and have had occasion to decry an attempt to rob him of his indefeisible right and property in his own labours, it is not necessary now to speak further, either in the way of explanation or commendation. In the present table the proportional parts, instead of being contained on a separate card, are printed beside the integral numbers. By this arrangement space and trouble are saved, and all the information which is usually requisite is condensed and presented at one view. We are afraid to say much in praise of the improvements which the author has effected in the calculation of earthworks, lest our observations should provoke the cupidity of some literary burglar: property in tables of earthworks is found to be so insecure, that the only safe way of retaining it seems to be by concealing it.

Incitements to Studies of Steam and the Steam-Engine; or, Practical Facts relative thereto Properly Appropriated. By W. Templeton, R.N. Woolwich. London: John Williams, 1848.

The object of this little book is to diffuse information on marine engineering, particularly to enable persons to prepare for the examinations for engineers in the navy. Of course, such a work will be equally useful for engineers in the commercial steam service. We think it likely to be very serviceable for those classes to whom it is addressed, and we therefore recommend it to our readers who feel an interest in the subjects to which it refers.

Mr. Templeton suggests as one of the uses of this little book, that although it is not professedly instructive for the higher branches of the profession, it may be found available as a ready prompter, for refreshing the memory on points of practice. By keeping up the standard of attainments among working-men, we think Mr. Templeton will do some good.

GEORGE STEPHENSON.

On the death of a great man it is a good time to think of what he has done. We are struck by the loss: the thought comes gloomily that he who so lately stood among us, whose smile still beams upon us, whose sayings are fresh in our ears, and whose looks have not faded from our sight, has ended his days here and sought another world. We begin to tell over his words and deeds, the great and good things he has done, his strength and his failings, his sorrows and his joys;—we hasten to snatch a last look before the bright remembrance is dimmed.

George Stephenson was so lately amidst us, in strength of body and mind unbroken, that it is hard to believe he lies in the cold grave; and the more so while his works speak so loudly of him. In mind he is among us, if not in body—indeed, his remembrance cannot so soon leave. The last duties have been paid—the earth has been laid upon him, his name is written on his coffin, and the newspapers have told of his birth and his death: but his brethren have yet much to think over. He has given the engineers of England a European name; he has opened for them a new field of employment at home, a wider field of honour and of wealth abroad, and they owe him heartfelt thanks.

When we look to the man, our hearts are stirred within us. We begin with his lowly birth, we witness his great rise, his wonderful works, but still more his kindly feelings; we wonder how he did so much from small beginnings, and every young man burns to follow in the footsteps of one so truly great and good. We have thought, therefore, a few words may be in good time now, gathered from the several books and papers in which they lie scattered, and which may perhaps be a spur to those able to do something worthier of the man.

His life is none the less useful as being that of a working-man, who by his own straight-forwardness raised himself to the topmost height; and as he began without school-learning, and in a private way, it opens many of those questions which have been much written upon of late years as to the teaching of engineers, and how far they should be under the sway of a government. Inasmuch, too, as, unlike many men of learning, he was most happy in earning wealth, and in keeping it, in a good name, and in the love of his household, it may be worth while to ask why he should have had a better lot than other men, and what share an upright and manly mind had in helping on a quick and ready wit. Many, indeed, think that a clever man may do as he likes, and that he need put no bridle on his wishes, nor trouble himself whether his deeds be right or wrong, but may be a good and successful engineer notwithstanding. Stephenson's life will tell us something on all these heads.

I. BOYHOOD.

George Stephenson was born in 1760, at a small and lone cottage between Close-House and Wylam, in Northumberland, and within nine miles of Newcastle, in the colliery district. He was one of several children, the son of poor people, who had long dwelt in the same neighbourhood, and who were very respectable. The elder Stephenson is said to have been a collier, but by other more likely accounts[1] an engine tenter at a colliery. That the parents were people of high character is best proved by the early life of the son, but most by his behaviour towards them.

Schooling they were ill able to give him, and it is not certain that he learned to read before he began to labour; but he had that best kind of teaching which comes from the heart. An open and upright mind was the true groundwork on which his greatness was built, and he owed it to the humble home in which he was brought up. We pride ourselves now-a-days that we have spread national schools over the land, and that we have taken care for the right bringing up of youth; and we think it much better that all can now learn to read and write. It may however well be asked, how far this alone is good; for we have struck a blow at that home-schooling, under which for so many hundred years Englishmen have been bred. Formerly, the cotter had the whole care of his children; the father and the mother were held answerable for their offspring, and if these ended ill, the shame was a by-word among the neighbours. Now, the child is handed over to the schoolmaster, without whose teaching life is held as nought, and whose reading and writing are to breathe worth into the boyish mind. It is no longer said learning is better than house or land, but that it stands in the stead of everything, and is worth itself. The work of father and mother is now at an end; and if any ill befall, they answer they sent the child to school, and if any be in the wrong it must be the schoolmaster. This is telling more than is believed, and is one of those things which is sapping England. How often must it be said that reading and writing are not to bring a child u while its body and its soul are untaught? and better is it to have the homely English breeding of George Stephenson than the mock useful-knowledge-schooling of Dr. Bell or the Prussians.

If not taught to write, George Stephenson was taught to be a good son, and an upright man; and thus in after-time to find in his own son a true helpmate, and one who fondly loved him. It is not likely that the lad felt any repining, but earnestly took up—what should be the lot in life of all—to work for his bread by the sweat of his brow. He never looked for anything else,—he had no yearning for idleness, and his mind never gave way under the burthen which was laid upon him in after-life. In common with his brothers he was early set to work to earn his share of the household food—so early, that his first earnings were only two-pence a day. He led the horse at the plough when almost too young to stride across the furrow;[2] riding him to his work betimes in the morning, when many children were still asleep, and had not begun their boyish play.

So lowly were his first endeavours, that they were given to the ploughshare or the coal-heap. Sometimes he wrought at picking bats and dross from the coal; and he was so young, and so young-looking, that he had often to hide himself when the overseer went round, lest he should be thought too little to earn his small living.[3] From twopence a day he rose to fourpence, and at length to six-pence a day,—as great a rise, and perhaps as fraught with brightest hopes and swelling pride, as when in after-years his locomotives moved from miles to scores, and when the maker of a short tram-way became the undertaker of iron roads between London and the millions of the north, and kings and statesmen smiled on the wonders he had wrought.

In his boyhood he was most marked among the playmates of the hamlet as foremost in their sports and pastimes,—and indeed we need not wish for more. His mind was not tasked beyond its strength, nor made to yield unripe fruit. The healthy growth of his body enabled him to work out whatever his powerful mind spurred him to do; and for twenty years of his life (from forty to sixty), he never flagged in tasks which the unbroken strength of youth can seldom master.

It is said that he early showed a mechanical turn, and that he mended the clocks and watches of the pitmen, and even made their shoes,[4] to eke out his boyish earnings; but it seems more likely that the watch and clock mending belonged to a later time of his life, for had he shown such a happy knowledge, it is hardly likely that his skill should have been so little thought of, as until his manhood it seems to have been.

Shortly after he had come into his teens, he worked as breaksman for Waterrow pit, on the tramway between Wylam and Newburn. By this time his father had moved from Wylam to Walbottle. The lad now set up his first servant, which was no other than a great dog, whom he taught to bring his dinner daily from Walbottle colliery to the tramway.[5]

He is said even at this time to have helped in keeping his father and mother,[6]—a homely deed, but one of which he had a greater right to be proud than of any engineering undertaking. A right English feeling in his love of kindred was always lively in his mind, and it showed itself in his fondness for his father, his son, and the children of his brothers, and in every deed of his life. While earnest to make his own way, he was no less so that those about him should get forward—nay, if it might be, even before him; and while his mind was still unbroken, he left his son to carry out alone the great works in which they had begun together.

II. KILLINGWORTH.

The Stephensons went to Willington and Killingworth, at which latter is a colliery belonging to Lord Ravensworth and his partners. Young George was now put to be stoker to a colliery engine, at one shilling a-day, and as he himself told—"In my younger days I worked at an engine in a coal-pit. I had then to work early and late, often rising to my labour at one and two o'clock in the morning."[7] It was at Killingworth, however, that his lot in the world was settled, for there he made his beginning as an engineer.

As his strength grew so did his work, and he went on until he became an engineman at 12*s*. a-week. This was a great step, as he never forgot, for some months ago being at Newcastle, he sent for an old fellow-workman to dine with him at the Queen's-Head hotel, and talk over old times.—"Do you remember, George," asked his friend after dinner, "when you got your wages raised?" "Well," said Stephenson, "what about that?" "You came out oth the office all smiles, and told us you'd got your wages raised to [illegible]s. a-week, and you were a man for life. Now, you would find it hard to tell what you have a-week." "Yes," answered he, laughing, "I dare say I should."[8]

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[1] Derby Reporter, August, 1848.

[2] Derby Reporter.

[3] Derbyshire Courier, August 19, 1848.

[4] Leicestershire Mercury.

[5] Gateshead Observer, August 19, 1848.

[6] Derbyshire Courier.

[7] Speech at Newcastle, June 18, 1844.

It was, however, a great step, for it had a share in his teaching. He was at home with the steam-engine, and with his searching mind he was storing up that knowledge which was to be most useful to him. It was a good working-school for a great engineer—as good as Brindley's in a mill, or Watt's in his workshop at Glasgow. His mind was awakened: he did not stand listlessly by to feed the fires,—but the engine lay before him as a book wherein to read its workings, to master its powers, to know its weaknesses, to task its cunning. There is something in the steam-engine which is a spell and a charm to the beholder,—something more and something else than the love of the sailor for his ship; such as the weaver feels not at his loom, nor the smith before his anvil. The smith or the weaver is the maker—the hammer or the shuttle works as his hand lists; but the steam-engine stands as with life and breath within it—working of itself, earnestly, steadily, and manfully; by day and by night, in its youth and in its elder years, when scores of men who wrought with it have sickened and breathed their last. To the working-man it is a thing of care and love, and its sight seems to give might to those who behold it, and to teach them the cunning which is in its own make. Thus, boys who watched strengthened it with cords and rods of iron;—thus, a toy in the hands of Watt, it claimed his life for its care, and grew to unwonted growth;—thus, time after time, have master and workman nursed its childhood, and helped it onwards to its mightiest strength—and Stephenson has not been among the least of these. The weaver does not better the loom; but day-by-day some lowly workman gives his small meed of help to the steam-engine.

The next step that we know of in Stephenson's onward path was his getting seventeen shillings a-week.[9] Whether this was at Willington or Killingworth is not settled; but soon afterwards he was at Killingworth, with a shilling a-week more, and sometimes putting to his slender earnings a little for his over-time or for piece-work.

He had now grown up to manhood, and to a good name among his neighbours, being, as those who now live remember, a hard-working and upright man, having the trust of his masters and of his fellow workmen.

One of the first deeds in which he is said to have shown his skill was at Killingworth. The sheaves over which the ropes work at the pit were much fretted as they were then made, and the ropes wore quickly away. Indeed, the ropes which elsewhere lasted three months, wore out at that pit in a month. This was a heavy outlay to the owners, and much trouble to the work-people. Many ways were tried, but fruitlessly; and at length they gave up all hope of a cure. Seeing the evil was great, Stephenson gave his mind to find out whence it arose; and having done so, he set to work and put the sheaves to rights, so that a rope was saved in two or three months.[10]

By this time he began to feel his own worth, and to yearn after something better than his then way of living; but he thought that to better his means, no other way was so good as to learn more, and fit himself for higher tasks. He had it in hand moreover to go to New England, whither the stream of settlers did not flow so fast as it does now, and where therefore greater hopes were held out to the skilful workman who chose to leave the Old World so far behind. In the beginning of this age, it was a greater task to go to America than it now is to go to New Zealand; and it shows young Stephenson's boldness that he undertook it. Nevertheless, it is not likely that it was his own thought, but that of one of the two men who were to be his fellows in the undertaking. One of these, named Wood, gave Stephenson a knowledge of writing and of numbers, which it therefore seems he did not learn until his manhood. It was the wish of Wood and Stephenson to try their hands in the New World at mechanics and farming, for which latter he had at all times a love.[11] If we remember that in those days the trip to America was costly, and that no one could go free, we may see that Stephenson must have had some thrift, when he was able from his slight earnings to save wealth enough for such a task. It shows, too, that he was not given to drinking or to waste, but had steered free of that shoal on which too many working-men are wrecked—the pot-house, in which their wages are swallowed up, their minds blasted, and their health worn out. We know, indeed, there were few evenings of George Stephenson's early life which were idly spent. First, he was kept late at his engine; afterwards his nights were spent in learning; by-and-by in earning the means for his son's schooling, and afterwards in working and learning by his side.

Beyond the prompting of Wood or his other mate, there was much in the times to work upon the mind of any thoughtful man in the lower walks of life. In 1800, a fearful dearth spread throughout Europe, and the want of bread was sorely felt among us. The war, too, had full sway—wages were low, food dear, and what was worse, the lot of the working-man was cast under the bitterest thraldom which ever befell Englishmen. George Stephenson, in common with every poor and friendless man in every hamlet throughout the land, might have been torn from his home and kindred at any hour by a press-gang; hurried off to sea, and kept in bondage, as many good tradesmen now in London have been, for ten long years or more without setting foot on English ground. He was open to the lot of the militia and the local militia, and could only find some one in his stead at a very great outlay. In many townships, wages were made up by the parish-board, and the hard-working man was made a beggar against his will. Such was the lot of the working-man, were he even husband or father: his life was not his own; his freedom hung by a thread, at the breath and will of others. George Stephenson, too, might have been pressed, as others were. These were the good old times—gone, it is to be hoped, never to come again; now almost forgotten, and even when read here it will hardly be believed that in boasting England such things were.

It could hardly be otherwise than that the manly English mind of George Stephenson should spurn the lot in which he seemed to be cast, and yearn for the freedom which was held out to him among our brethren on the other side of the great sea; and had he gone, we should have lost him as we have so many other men of great mind—lost to England, and gone to swell the wealth and fame of America, and keep up the race of life against us. Those who know our best working-men, are well aware how wistfully they look to those lands where they can share in the birthright of their fathers, and how often they give up a good livelihood at home for the love of that freedom which is withheld from them in England by the working of the laws. Irishmen go to Canada or New Brunswick; but the Englishman who leaves home, goes not to our settlements, but to the United States—for he seeks more than bread. If, too, a man of quick mind, he is not shut out by burthensome patent-laws from reaping the fruits of his skill; and the best wealth he takes with him is often some bright thought, which ripens in the new land he has chosen. We may follow in our mind's eye George Stephenson across the seas, and behold him building at Philadelphia the engines and railways of which he has here made us proud. These are things little thought of—but still worth thinking about, for they come home to the bosom of every free-minded working-man among us.

It was unwillingly, and with sorrow, Stephenson thought of leaving his kindred and his best beloved, his homestead and the land of his birth, of his boyish games and of his early manhood. It went against his heart; but he felt upon him the strong call to free himself from the thraldom which beset him round. Thus he told afterwards to one who knew him: he said, "You know the road from my house at Killingworth to such a spot.—When I left home and came down that road, I wept, for I knew not where my lot would be cast."[12] How bitter must have been the thought to one who felt so deeply.

It was not, however, to be so—we were not to lose him. While his lot hung by a thread, and day by day the time for leaving drew nearer, he had every morning as he went to his work to pass a newly-sunk pit, whence they were endeavouring to draw the water; and time after time did he see the pit overseers and engineers striving bootlessly to get through their work. In one of his walks he stopped to look, and could not help saying to some of those around, that if they would let him, he could, to use his own words, "set them to the bottom." He was at first laughed at, but at length they left him to have his way; and he went through with it so as fully to answer to what he had held forth.[13]

This gave him a name among the neighbours as a skilful man; and he was no less happy with an engine which had been put up to pump water at a pit, but would not do its work, for it could not be made to pump. As is said at all such times, the skill of the whole neighbourhood was overcome, and Stephenson came in as the last doctor, to make the cure, and make it more wonderful. He said he could make the engines pump in a few hours; and though not believed, he did so, to the delight of the overseers.[14] Whether this was the same work as that already named we cannot say, for by some it is told as two things. One writer[15] says it was a large condensing-engine, made to draw water from the pit, and which had gone wrong. After several fruitless trials to mend it, Stephenson had the rashness to undertake the job, which he did fully —and moreover made some improvements in the engine. Stephenson himself said[16] that he had made some improvements in engine work. This, however, is sure—that he had got the trust of the pit-owners; and, having a better hope of livelihood, he gave up the thought of settlement abroad, and made Killingworth his home for some time.

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[8] Gateshead Observer.

[9] Derbyshire Courier.

[10] Derby Reporter—Derbyshire Courier.

[11] Derby Reporter.

[12] Derby Reporter.

[13] Derbyshire Courier.

[14] Derbyshire Courier—Derby Reporter.

[15] Gateshead Observer.

When he was twenty-two years old, he wedded a young woman of the neighbourhood; and in 1803, his son Robert was born; but he had no other child. In the life of another man, the birth of a child would not be worth naming; but with his fatherly fondness, the child became the apple of his life, until he grew up to be his fellow-workman, to earn a great name, and to hold that standing among the mighty of the land which the father would not take. All went so happily with George Stephenson, that everything seemed to fit him. He was able to give his only son that breeding and that schooling, which, if he had had many children, would perhaps have been beyond his reach—though it is hard to spell what never happened. This, however, we may say—that Robert Stephenson owes his greatness to the unshared care of his father, who shaped his mind from earliest years to the full strength of manhood. Paintings have been drawn of the fondness felt by a mother in watching the growth of an only son; but there is something dearer in the father, like George Stephenson, who, in the son of his youth, not only sees, but shares, in the growth of a great and manly mind. The mother can but be as a looker-on, and cannot feel his deeds to the full; but the father, while watching with the eye of a master, takes share and part in the toil. To few men this happens; for, in the common way of things, a man weds late in life, and the son comes upon the world only as the father is leaving it, and before the strength of manhood has ripened to its full.

The engineman had now become a stripling engineer, and began to look out for a wider field. He seems to have tried his hand on most kinds of colliery work. It is said that he laid down some tramways, or wagon-ways as they are named in the north, and made some improvements in them.[17]

He was now getting a good name among the neighbouring land and coal owners, and had got on the high-road to engineering. Instead of being pinned to the stake, as a workman by the day or week, it was open to him to rise as others had done around him, and to make his way as a mining engineer. The colliery school was a better one for breeding great engineers than even that of Cornwall; for it had all that Cornwall had, and more too. The Cornishman could learn the steam-engine, pump-work, and mine surveying; he saw enough of sinking, and driving, and draining. The Northumbrian, however, while he had all these to learn by, having a greater bulk to move, had to look more to the roads and ways on which so many thousand chaldrons were borne to the ship-side. Hence, in Northumberland, many men had turned their skill towards the roads and wagon-ways, to the rails and sleepers, and to the works and bridges by which they were borne over the rivers and hollows. Both had the same school in the works of the millwright and the iron-founder, but the Northumbrian was better off; because, instead of the outaway, small towns of Truro, Redruth, and Camborne, he had near him Newcastle, on the high road from London to Scotland; and having its booksellers, schools, and men of learning. He was much nearer to the world than his Cornish brother, truly at the Land's-End. The north, therefore, has given us more civil engineers than the west, though the latter has its Trevithick and its Woolf.

By Lord Ravensworth, and others, Stephenson was employed in putting up steam-engines, and sloping planes under-ground; and in one pit, two or three engines were made to do the work of nearly 100 horses.[18]

We have seen that Stephenson had a love of knowledge, by what he had learned with Wood; and we know that he must have schooled himself much at this time, from what he soon afterwards did. It is true, he was not fond of reading, but he always liked to know everything thoroughly; and he did not leave out anything whereby what he undertook could be well done. It was always his wish to go to the ground-work, and to build steadily up; and he had a great dislike for those engineers who undertake anything carelessly or rashly. As he himself said,[19] he had too "frequently noticed the miscalculations of hundreds of engineers, for want of studying the laws of mechanics, and knowing that a pound could only weigh a pound." It was on that sound knowledge that his trust in himself in after-life was built, and that he was able fearlessly to stand up before the House of Commons and the people, in his great struggle for the locomotive against the lights of the day.

III. THE LOCOMOTIVE.

Stephenson was now getting beyond his thirtieth year, his mind strengthened by knowledge, and by the trust that what he might do would reap its full reward. His child was growing up to boyhood, while his earnings were still so slender that he could do but little for his schooling. He had at this time felt bitterly his own want of learning, and he made up his mind that he would put his son to a good school, and give him good breeding. "I was, however," said he afterwards at a meeting at Newcastle,[20] "a poor man; and how do you think I did?—I betook myself to mending my neighbours' clocks and watches at night, after my day's work was done; and thus I got the means of bringing up my son." This he might well say with boasting, for it is one of the bright lights in his life.

The great draught of coal on the tramways, and the heavy trains which went forth from the pits, had set the minds of many at work to use steam instead of horses to draw the loads. The stationary engine worked well on the incline, but the steam-horse was called for to run throughout from the pit's-mouth to the ship's-side. In 1758 or 1759, Dr. Robison, then a young man, had hinted to Watt to put steam to work wheel-carriages.[21] Watt, however, had other things on his mind, though he named it in his patents of 1769 and 1784; but as Watt had a dislike for high-pressure steam, that may be one cause why he never made a locomotive.[22]

About 1763, John Theophilus Cugnot, a Lorrainer, showed a model of a steam-carriage to the Count de Saxe. He afterwards went to Paris, and got the help of the Duke de Choiseul. In 1769 he built an engine at the cost of the king, and it was tried in 1770. It moved with such strength, that it knocked down part of a wall which stood in its way; therefore some thought that the power was too strong to be kept within bounds, and not fit for common use.[23] It is said the engine was given up and put in the Arsenal Museum, and is now kept in the Conservatoire des Arts et Métiers. It would be worth while for any engineer who may be in Paris to look after it.

In 1782 or 1792, Murdoch made a model of a steam-carriage at Redruth. This was perhaps the beginning of Trevithick's, who is said to have been brought up under Murdoch, and who knew him well.

In 1786, Oliver Evans laid a plan for steam-wagons before the commonwealths of Pennsylvania and Maryland, and the latter gave him a privilege for fourteen years—yet he was never able to get money enough to build a wagon. All that he did was in 1804 to put wheels on a steam dredging-machine he had made for cleansing docks, and which he made to move slowly, though in a cumbersome way.[24]

On March 24, 1802, Trevithick and Andrew Vivian took out a patent,[25] which among other things was for the use of high-pressure steam for carriages, and by which the weight of the engine was brought very low. A carriage was made and run in Cornwall, and afterwards in London. Another was made in 1804 in South Wales, which was worked on the Merthyr Tydvil Railway, and "drew after it as many carriages as carried ten tons of bar-iron, from a distance of nine miles, which it performed without any supply of water to that contained in the boiler at the time of setting out; travelling at the rate of five miles an hour."[26] The engine had an eight-inch cylinder, and the piston a four-feet six-inches stroke.[27]

These engines fell into dislike, from the one on the Merthyr Tydvil railway blowing up,[28] having been made (against Trevithick's orders) without a safety-valve, and likewise from the wrong belief which got about that the wheels had no bite on the rails, and could not work up a slope.[29]

One of Trevithick's engines was sent, singularly enough, to George Stephenson's birth-place, to Mr. Blackett, of Wylam; and thus it came within his sight. This happened most strangely, and most luckily, for the mind of Stephenson was now brought to bear on the great work of his life. The finding of Trevithick's model by Uvillé was strange, and most fruitful in the deeds it brought about; but perhaps we owe more to the Wylam engine. On some ground or other, the engine does not seem to have been put to work on the tramway, but was used to blow a cupola in an iron-foundry at Newcastle.[31] This engine had one cylinder only, and a fly-wheel to secure a rotatory motion in the crank at the end of each stroke. If Mr. Blackett did not however work this engine, he had another of the same kind made and set upon his tramway at Wylam; and in 1813 it worked by the adhesion of its wheels on the rails, thus upsetting the belief that the engine could not so work.

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[16] Trent Valley Meeting.
[17] Gateshead Observer.
[18] Derby Reporter.
[19] Trent Valley Opening.

[20] Newcastle and Darlington Opening.
[21] Robison's Mechanical Philosophy.
[22] Penny Cyclopædia.—Art. "Steam-Carriage."
[23] Stuart's "Steam-Engine."
[24] Mechanics' Magazine, No. 372.
[25] Repertory of Arts, 2nd ser., vol. iv., p. 241.
[26] Wood on Railroads, 1st edition, p. 127.
[27] Stuart's Steam-Engine, p. 460.
[28] Railway Register, vol. v.
[29] Lardner on the Steam-Engine, 1840, p. 336.
[30] Stuart's Anecdotes of the Steam-Engine.—Civil Engineer's Journal, "Life of Trevithick."—Railway Register, vol. v.
[31] Wood on Railroads, 1st, 2nd, and 3rd edition,—2nd edition, p. 129.

On the 30th December, 1812, William and Edward Chapman took out a patent for an engine, with additional wheels to work upon a chain stretched along the middle of the railway the whole length. This engine was tried on the Heaton tramway, near Newcastle, but given up.

On the 22nd May, 1813, William Brunton, of Butterley, took out a patent for a locomotive with legs. This was tried and worked. In 1811, Mr. Blenkinsop had hit upon the plan of having a cog-wheel and cog-rail to overcome the adhesion.

At this time, Mr. Blackett was fully at work experimenting on the Wylam railway with an ill-made engine of Trevithick's, which was found to be very troublesome, as the irregular action of the single cylinder made jerks in the machinery, so as to shake it in pieces. Still, the whole of the coals were taken down the tramway by this kind of engine.[32]

By this time George Stephenson was likewise at work; and Lord Ravensworth and the Killingworth owners had such trust in him, that they gave him the money to make an engine in the opening of 1814, and on the 25th or 27th July, 1814,[33] it was tried on the tramway. As Stephenson said Lord Ravensworth and his partners were the first to intrust him with money to make a locomotive engine, "We called it *My Lord*. I said to my friends, there is no bound to the speed of such an engine, if the works can be made to stand it."[34]

The engine had two cylinders, each eight inches diameter and two feet stroke; the boiler was cylindrical, eight feet long and thirty-four inches diameter; the tube twenty inches diameter, passing through the boiler. The cylinders worked two pairs of wheels by cranks placed at right angles, so that when the one was in full operation, the other was at its dead points,—by which means the propelling power was always in action. The cranks were held in this position by an endless chain, which passed round two cogged wheels placed under the engine, and which were fixed on the same axles on which the wheels were placed. The wheels in this case were fixed on the axles and turned with them.[35]

The trial was made on a piece of road laid with the edge-rail, rising about one in four hundred and forty, and was found to drag after it, besides its own weight, eight laden wagons, weighing altogether about thirty tons, at the rate of four miles; and after that time it kept steadily at work. The application of the two cylinders made the working of the engine regular, and secured the steady progressive motion which was wanted in the Wylam engine, there being only the single cylinder and fly-wheel.[36]

It was not till the next year that Stephenson took out a patent for his locomotive, and here we find the bad working of the patent laws as bearing upon our poor workmen. Had it not been that his first engine was not perfect, he could have had no patent, and would have reaped no fruit from his days and nights of toil, as he could not raise the money to pay the heavy fees which are drawn from the patentee. Even for his first trial he wanted money, and for which he was beholden to the kindly feeling of Lord Ravensworth: much happier than Oliver Evans, who fruitlessly sought in America and England for the means wherewith to start his steam-wagon.

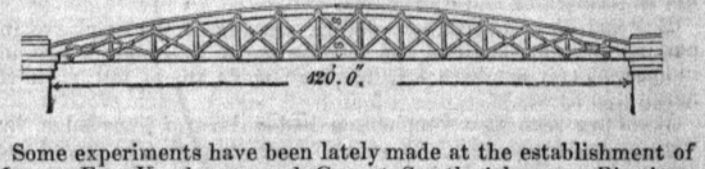
Here we may rest for a time, and think a little as to what led Stephenson on in the world. No man could be worse off for money or means: he had no powerful kinsmen, no wealth left him by a father; his earnings were barely enough for the wants of himself and his son; his standing was lowly; he had no rich schoolfellows or friends who had known him from childhood. Within twenty years from this time he had, however, got together houses and land, and at his death left behind him wealth which he never durst have hoped for. Brindley was not so happy in the end, neither was Trevithick, nor Dodd. Watt began in a small shop—but he belonged to the middle classes, and had not the hard task of working himself up from the lowest depths of life. If, however, he gathered riches, he owed it to the fostering care of Boulton, without whom he would have spent his income in undertakings which had not within them the seeds of wealth, whatever else could be said for them. He would have made the finest machinery for copying statuary; he would have tried to the utmost cures for illnesses of the lungs by breathing gases,—but he would have died worth not one halfpenny.

Fulton wandered through the Old World and the New, begging kings and commonwealths to give him the means of building steamships. We have seen that the utmost luck of Oliver Evans with his steam-wagon was to get rights which were of no use to him, and to turn the wheels of a ballast-engine. Dodd, after planning two of the greatest bridges on the Thames, and spending thousands in bringing steamboats into use, died unhappily.

Trevithick, after trying one thing after another, and finding friend after friend to help him, did, two years after Stephenson's beginning at Killingworth, leave England for the West Indies; whence he did not come back, and that penniless, until Stephenson had laid down the Stockton and Darlington Railway. Trevithick was taken up by Mr. Blackett, a bold and daring man, and sent a locomotive to Wylam, which, like most things in which he had a hand, was so wretchedly made that it was put to other uses. Mr. Blackett made another, and Stephenson had it as a model to shape something better. Trevithick began better than Stephenson: he had friends in Cornwall and in London; and he ought not to have left to Stephenson to work out the locomotive engine and the railway. Trevithick was always unhappy and always unlucky; always beginning something new, and never ending what he had in hand. The world ever went wrong with him, as he said,—but in truth, he always went wrong with the world. The world had done enough for him, had he known or had he chosen to make a right use of any one thing. He found a partner for his high-pressure engine,—he built a locomotive,—he had orders for others for Merthyr Tydvil and for Wylam,—he set his ballast-engine to work,—and he drove his tunnel under the Thames for a thousand feet;—but no one thing did well: all were afraid, and at length no one would have anything to do with him. It was not that his mind was more fruitful than that of Stephenson, who in this short time had made improvements in pit-work and railways, built a locomotive, and found out the safety-lamp, and who throughout his life was ever working out something new. What it was, was this—Stephenson never lost a friend, and Trevithick never kept one. To the day of his death, Stephenson had among his friends those who had given him a helping hand in early life; and from year to year he went on strengthening the bonds of friendship with them and their sons, and the younger men who grew up around him. The Ravensworths, the Peases, the Brandreths, Matthew Bell, the Meynells, and others of his earlier friends, will be found with him throughout, standing by him as directors in his great railway undertakings, as they had befriended him in his small beginnings. This was a great strength to him, and though poor he had a mine of wealth in the purses of his friends. A manly and upright Englishman, open in speech, steady, straight-forward, and hard-working, he earned their friendship and never lost their trust; and if to others he was known as a great engineer, to them he was better known as an upright man. This made the poor working-man the rich manufacturer and great mine-owner. This gave him the means of doing what Trevithick and Evans could only talk of.

(To be continued.)

WROUGHT-IRON BOWSTRING GIRDERS FOR BRIDGES.



Some experiments have been lately made at the establishment of Messrs. Fox, Henderson, and Co., at Smethwick, near Birmingham, on a wrought-iron Bowstring Tubular Girder Bridge, of a similar construction to the one designed by Mr. Harrison, and given in our *Journal* in January last.

The experiments were made on a wrought-iron rib or girder, 120 feet clear span, in the presence of the Government Inspectors of Railways, and Government Board of Commissioners for inquiring into the Strength of Iron. The girder is constructed entirely of wrought-iron, and consists of an arch of boiler-plates and angle-iron, tied across at the ends by horizontal bars; and the tie-bars are connected with the arch by vertical standards, and by a double system of diagonals, which have the effect of distributing over the whole curve of the arch the action of weights placed on, or passing over, any point of the bridge. The proof was applied by loading the bridge rib with 240 tons of rails, bars, &c.; and it produced the following satisfactory results, as the weight was applied :—

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[32] Wood on Railroads, 2nd edition, p. 134.

[33] Wood on Railroads, 2nd edition, pages 134 and 136, where different dates are given. In the report of Stephenson's speech at Newcastle in 1844, he is made to say that the date was 32 years before, which would be in 1812. This is a mistake.

[34] Speech at the Newcastle and Darlington Opening.

[35] Lardner on the Steam-Engine, p. 340.

[36] Wood on Railroads, 2nd edition, p. 136.

Weight in tons of rails, &c., placed on the cross-girders.	Extreme amount of deflection produced at centre of arch
34¼ tons	0 1-16th inches.
69½ "	0 5-8ths "
102¾ "	1 5-16ths "
137 "	2 1-8th "
171¼ "	2 3 4ths "
205¼ "	3 5-16ths "
240 "	3 11-16ths "

The proof weight was fixed at 240 tons, as being double the greatest load which the bridge can by any possibility be ever required to bear. A heavy goods' train weighs less than half a ton per foot lineal; a train, consisting entirely of locomotive engines (which would be heaviest of all possible trains) would only weigh one ton per foot lineal, and, consequently, would place a load of not more than 120 tons on a bridge of 120 feet span. The new bowstring bridge has, therefore, been proved to twice the weight which ever can be placed upon it, and to four times the weight which it is ever likely to have to bear. It is scarcely necessary to add, that the trial gave great satisfaction to all parties. These ribs are adapted for large spans, in cases where either headway is of importance, or where sufficient abutment cannot be obtained without very heavy expense. Bridges constructed of these ribs may be employed with perfect safety for very large spans, in precisely the same manner as ordinary girders are used for small ones. The strength of the bridge depends upon the rib or arch, and on the tie-bars by which the extremities are held together. The vertical standards are introduced, partly to suspend the load from the arch, and partly to obtain longitudinal and transverse firmness; they also support the tie-bars. The diagonals are employed for the purpose of preventing undue deflection in the rib, when the bridge is unequally loaded. The rib itself is constructed of boiler-plates and angle-iron, rivetted up in the form of a square hollow trunk; it is strongly tied together, so that the full section of the plates and angle-iron may be depended upon to resist the crushing strain. In order to give this trunk additional lateral stiffness, the side-plates, which form the top, overhang, and are strengthened on the edges by angle-iron, &c. The tie-bars measure about 8 inches, by 1 inch each, and are introduced in sufficient number to take the whole strain. The ribs are supported at each end on cast-iron shoes, fixed at one end to the piers, and mounted at the other on sliding-frames and rollers. This arrangement provides, not only for expansion and contraction, but also for motion under a very heavy load. The action of these parts under proof has been found to be perfect. Cross-girders, constructed entirely of wrought-iron, are suspended between the ribs.

Besides the above experiments on the Blackwall Extension bridge, the two ribs for a bridge, 130 feet span, have been proved with a weight of 260 tons—that is, 2 tons per foot lineal each, put on in dead weight, by suspending cast-iron cross-girders underneath the points where the wrought-iron girders are intended to be attached, and by placing thereon 260 tons of rails, pigs, bars, &c. In proving, the load was first put on two points at one end, then on the next two points, and so on, in order to produce as nearly as possible the same effect as the passage of a heavily-loaded train. In the case of one rib, the load was allowed to remain several days, and then removed. After the lapse of a few days, the same load was replaced, and again allowed to remain some days. The results were satisfactory.

During the process of proving, observations were taken with a level, placed at a distance; and the sinking of the bearing-plates in the ground was observed and noted. The bridges being now constructed, are intended to carry a double line of rails; and the test applied is, therefore, equal to 2 tons to each foot lineal of single line of way. This test was fixed upon in the belief that the greatest possible load which can in working be placed upon each line of rails is about 1 ton per foot lineal; and that, to provide for the additional strain caused by the rapid motion, &c., of the practical load of trains passing, the proof weight ought to be fixed at double the greatest possible load. In very large spans, (say 400 feet, and upwards), it would be necessary, on many accounts, to use four ribs, instead of two, and to brace all the four ribs together overhead, so as to obtain additional transverse stiffness.

We understand that several girder-bridges of the above construction are to be erected on the Blackwall Extension Railway, under the superintendence of Joseph Locke, Esq.

DRAINING MARSHES BY STEAM.

The following paper, "*On the application of Steam-power to the Drainage of Marshes and Fen Lands*," was read at the recent meeting of the British Association, by Mr. GLYN.

The number of districts in which I have successfully applied the steam-engine to drainage is fifteen, and the quantity of land so drained amounts to more than 125,000 acres; the engines employed being 17 in number, and their aggregate power 870 horses, the size of the engines varying from 20 to 80 horse-power. I was also engaged in draining the Hammerbruk District, close by the city of Hamburg; and in another district near to Rotterdam, an engine and machinery with the requisite buildings were erected from my plans by the Chevalier Conrad. In many of the swampy levels of Lincolnshire and Cambridgeshire much had been done to carry off the water by natural means; and many large cuts had been made and embankments formed—especially in the Bedford-level, which alone contains about 300,000 acres of fen land; and the great level of the Fens contains about 680,000 acres, now rich in corn and cattle. The Dutch engineers who had been engaged in these works had erected a number of windmills to throw off the water when the sluices could not carry it away. By the aid of these machines the land was so far reclaimed as to be brought into pasture and cultivation, producing occasional crops of wheat. The waters from the uplands and higher levels were intercepted by catch-water drains, which carried away as far as might be practicable the highland waters, and prevented them from running down upon the fen; but as it often happened, when there was most rain there was least wind, and the wind-engines were useless when their help was most needed, and the crops were lost.

In this state was the fen country when the steam-engine was introduced; and by its aid the farmer may venture to sow wheat upon these rich levels with as much confidence and even more than upon higher ground; for not only can he throw off at pleasure the superfluous water, but in dry weather a supply can be admitted from the rivers—so that farming in such cases is rendered less precarious than in situations originally more favoured by nature. It is, however, to be remarked that the quantity of rain which falls in these levels on the eastern side of England being much below the general average of the kingdom, the power required to throw off the superfluous water is small compared with the breadth of land to be drained; the proportion seldom being greater than 10-horse power to 1,000 acres, and in some cases considerably less.

The general plan is to carry away the water coming off the higher grounds, and as far as may be practicable prevent it from running down into the marsh by means of the catch-water drains before-mentioned, leaving the rain water alone to be dealt with by mechanical power. As the quantity of rain falling in the great level of the Fens seldom exceeds twenty-six inches, and about two-thirds of this quantity is carried off by evaporation and absorption, or the growth of plants, it is only in extreme cases that two inches in depth require to be thrown off by the engines in any one month —which amounts to 1⅓ cubic foot upon every square yard of land, or 7,260 cubic feet to the acre. The standard and accepted measure of a horse's power is 33,000 lb. raised one foot in a minute, or 3,300 lb. raised ten feet in the same time; and as a cubic foot of water weighs 62½ lb. and a gallon of water 10 lb., so a horse's power will raise and discharge at a height of ten feet 330 gallons, or 52·8 cubic feet of water in a minute. Consequently this assumed excess of 7,260 cubic feet of water fallen upon an acre of land will be raised and discharged at an elevation of 10 feet in about two hours and ten minutes.

If the quantity of land be 1,000 acres of fen or marsh, with the upland waters all banked out, the excess of rain, according to the above estimate, will amount to 7,620,000 cubic feet. A steam-engine of 10-horse power will throw off this water in 232 hours, or in less than 20 days, working 12 hours a day; and I have found this calculation fully supported in practice.

Although the rain due to any given month may fall in a few days, yet in such a case the ground will absorb a good deal of it, and the drains must be made of a capacity large enough to receive and contain the rain as it falls;—besides, in cases of necessity, the engine may be made to work 20 hours a day instead of 12, until the danger is past. I have generally caused the main drains to be cut 7½ feet deep, and of width sufficient to give them the required capacity to receive the rain water as it falls and bring it down to the engine. In some instances—where the districts are extensive and their length great—it has been found requisite to make them somewhat deeper.

In all cases where I have found it necessary to use steam-power, I have applied scoop-wheels to raise the water. These scoop-wheels somewhat resemble the undershot-wheel of a water-mill; but instead of being turned by the impulse of the water, they are used to lift it, and are kept in motion by steam-power. The float-boards or ladle-boards of the wheels are made of wood, and fitted to work in a trough or track of masonry; and they are generally made 5 feet in length—that is to say, they are immersed 5 feet in the water—and their width or horizontal dimension varies, with the power of the engine and the head of water to be overcome, from 20 inches to 5 feet. The wheel-track at the lower end communicates with the main drain, and the higher end with the river, the water in the river being kept out by a pair of pointing doors, like the lock gates of a canal, which close when the engine ceases to work. The wheels themselves are made of cast-iron, formed in parts, for convenience of transport. The float-boats are connected with the cast-iron part of the wheel by means of oak starts, which are stepped into sockets cast in the circumference of the wheel to receive them. There are cast-iron toothed segments fitted to the wheel, into which works a pinion upon the crank-shaft of the engine.

When the head of water in the river or delivering drain does not vary much, it is sufficient to have one speed for the wheel; but when the tide rises in the river, it is desirable to have two speeds or powers of wheel-work—the one to be used at low-water, and the other more powerful combination to act against the rising tide. But, in most cases, it is not requisite to raise the water more than three or four feet higher than the surface of the land intended to be drained—and even that is only necessary when the rivers are full between their banks, from a continuance of wet weather or from upland floods. In some instances, the height of the water in the river being affected by the tide, the drainage by natural outfall can take place only during the ebb; and here, in case of long-continuing rains, the natural drainage requires the assistance of mechanical power.

I have stated that the main drains have generally been made 7½ feet deep, or more in larger districts—so that the water may never rise higher than within 18 inches or 2 feet of the surface of the ground, and the ladle or float-board dip 5 feet below the water, leaving a foot below the dip of the wheel, so that the water may run freely to it, and to allow for the casual obstruction of weeds in the main drain—which if it be sufficiently capacious and well-formed, will bring down the water to the engine with a descent of 3 inches in a mile. Suppose, then, that the wheel dip 5 feet below the surface of the water in the main drain, and that the water in the river into which this water must be raised and discharged has its level 5 feet above that in the drain, the wheel in such case will be said to have 10 feet head and dip, and ought to be made 28 or 30 feet in diameter. I have found it practicable to throw out the water against a head of 10 feet, with a dip of 5 feet,—that is to say, 15 feet head and dip with a wheel 35 feet in diameter; but in another engine more recently erected I have made the wheel 40 feet in diameter. The engine that drives that wheel is of 80-horse power, and is situated on the ten-mile bank near Littleport, in the Isle of Ely.

The largest quantity of water delivered by one engine is from Deeping Fen, near Spalding. This fen contains 25,000 acres, and is drained by two steam-engines—one of 80 and one of 60-horse power. The 80-horse engine has a wheel of 28 feet in diameter, with float-boards or ladles measuring 5½ by 5 feet, and moving with a mean velocity of 6 feet per second. So that the section of the stream, when the engine has its full dip, is 27½ feet, and the quantity discharged per second is 165 cubic feet—equal to more than 4½ tons of water in a second, or about 16,200 tons of water in an hour. It was in the year 1825 that these two engines were erected, and at that time the district was kept in a half-cultivated state by the help of 44 windmills—the land at times being wholly under water. It now grows excellent wheat—producing from 4 to 6 quarters to the acre. In many districts land has been purchased at from 10*l.* to 20*l.* an acre by persons who foresaw the consequences of these improvements, and which they could now sell at from 50*l.* to 70*l.* an acre. This increase in value has arisen not only from the land being cleared from the injurious effects of the water upon it, but from the improved system of cultivation which it has enabled the farmers to adopt.

The fen lands in Cambridgeshire and in part of the neighbouring counties are formed of a rich black earth, consisting of decomposed vegetable matter, generally from 6 to 10 feet thick, although in some places much thicker, resting upon a bed of blue gault, containing clay, lime, and sand. When steam-drainage was first introduced, it was the practice to pare the land and burn it; then to sow rape-seed, and to feed sheep upon the green crop; after which wheat was sown. The wheat grown upon this land had a long weak straw, easily bent and broken, carrying ears of corn of small size, and having but a weak and uncertain hold by its root in the black soil. Latterly, however, chemistry having thrown greater light upon the operations of agriculture, it has been the practice to sink pits, at regular distances, through the black earth, and to bring up the blue gault, which is spread upon the surface as a manure. The straw—by this means taking up an additional quantity of silex—becomes firm, strong, and not so tall as formerly, carrying larger and heavier corn; and the mixture of clay gives a better hold to the roots, rendering the crops less liable to be laid by the wind and rain; whilst the produce is most luxuriant and abundant.

REGISTER OF NEW PATENTS.

THE STEAM HAMMER.

JAMES NASMYTH, and HOLBROOK GASKELL, of Manchester, engineers, for "*certain improvements in machinery or apparatus for forging, stamping, and cutting iron and other substances.*"—Granted February 23; Enrolled August 23, 1848.

This patent is for improvements in the steam-hammer, for which invention patents were granted to the same parties in 1842, 1843, and 1844. The principal object of these improvements is to regulate the action of the hammer with greater facility, by working the lifting-cylinder by means of an additional small steam-cylinder. The general arrangement of the primary parts remain very similar to the hammers now in general use. As is well-understood, the hammer is lifted by admitting the steam below the piston in the cylinder, and, by allowing the steam to escape, the hammer, by its own gravity, falls and gives the required blow. In the present invention, the force of the blow is regulated more conveniently than before. For this purpose, there is a small steam-cylinder for working the main slide-valve. This cylinder is fitted with a piston, connected by means of a rod to the main slide, to which the steam is admitted from the boiler. The small cylinder is furnished with three steam-passages similar to ordinary high-pressure engines, admitting steam alternately above and below the piston, and regulated by the slide-valve. This valve is connected by a rod to the piston of another cylinder, which is subject to the pressure of the steam from the main cylinder on the under-side, and is depressed by steam entering from a tube communicating with the valve-jackets of the slides. Steam having been admitted to the working-cylinder, the piston is elevated, and to regulate the height of the fall, a cock or valve is opened, communicating with an opening in the cylinder. This permits a rush of steam to flow into a pipe, which conveys it thence below the piston, raising it by the pressure of the steam on the under surface. The effect of this movement is to produce the requisite change in the position of the valve, so as to suffer the steam which entered the small cylinder above the piston, to escape into the atmosphere; and by the entrance of steam below the piston, it elevates the valve, so as to cover the steam-passage to the cylinder and the eduction-port, thereby suffering the steam to escape from the main cylinder; consequently the hammer, by its own gravity, will fall from the height to which it has been raised. There are three passages, each furnished with a valve or stop-cock, the levers of which are connected by rods to hand-levers, by which they may be opened or shut at pleasure; therefore, if the hammer is not required to fall from a height greater than the first opening, the valve connected therewith must be closed and the one above it opened, when the same action will be produced whenever the piston is elevated above such opening by the escape of steam. Two other methods of regulating the action of the hammer are shown in the specification, but the one we have noticed is sufficient to show the nature of the invention.

The patentees claim:—First, the application and use of an additional slide-valve, piston, and cylinders, or any of these parts separately, for the purpose of working the piston of the larger cylinder, and thereby actuating the main slide, so as to produce the alternate admission and escape of steam to and from the main cylinder.—Secondly, the employment of apertures in the main cylinder, for the purpose of working the piston and main slide, thereby effecting the motion of the hammer and regulating the various heights to which is raised.—Thirdly, the use of a vessel, with its plug or cock, so as to regulate the interval of time required for the falling of the hammer from the various heights to which it is elevated.—Fourthly, the application of a valve, placed in the eduction-port of the main cylinder, for actuating the valve, so as to effect the required change of the piston, and with it the main slide-valve, thereby actuating the hammer, and also for the purpose of obtaining the lapse of the required interval of time for the fall of the hammer.—Fifthly, the application of a latch-lever motion to the moving of the small slide-valve in one direction.—Sixthly, the combination of the latch lever-motion with the arm, and other parts connected therewith, by which motion is also transmitted to the valve, in the reverse direction, instead of employing the small cylinder for that purpose.—Seventhly, the application of the screw, and parts connected therewith, for the purpose of regulating the height to which the hammer is elevated.—And, lastly, they claim the moving of the main slide-valve, direct from the piston, and also without the intervention of the main slide.

DECORATIVE ARTS.

Miss **Elizabeth Wallace**, of Laurel-lodge, Cheltenham, spinster, for "*Improvements in facing, figuring, designating, decorating, planning, and otherwise fitting up houses and buildings, parts of which are applicable to articles of furniture.*"—Granted February 28; Enrolled August 28, 1848.

The improvements in the decorative arts patented by Miss Wallace are divided in the specification into ten kinds, though the distinguishing feature in the invention is the production of the effects of marble, malachite, &c., by casting tablets of plaster of Paris on to glass, the glass or plaster being coloured or decorated to give the required effect. These tablets are intended to be applied both externally and internally, the internal decorations being of course more ornamental than the tablets used to imitate marble, &c., on the exteriors, and they are to be fixed to the walls by cement and long copper nails. Among other parts of the invention is a mode of producing the appearance of gold without employing any metal, and it is thus described:—"To make a flat tablet of this description, I take a plate of figured yellow glass (the nearer the colour of gold the better); to the back of this I attach a plate of plain yellow glass silvered; and I unite the two plates of glass by cementing them at the edges with gutta percha, or any other suitable cement. The result of the combination is, that the figured parts of the upper glass exhibit the appearance of deadened or frosted gold, with a groundwork of burnished gold, or *vice versâ*. Sometimes I substitute for the front plate of figured yellow glass, a plate of white glass, figured or ground (the whole of it, or parts only); and sometimes I also dispense with the second sheet of glass altogether, and apply the silvering at once to the back of the figured or ground front plate."

In another part of the specification is described the following process for giving additional brilliancy to painted glass:—"As regards stained, or painted, or other figured glass—I take a sheet of plain white glass, give it a coating of gum, then sprinkle over it a quantity of what are known in the glass trade by the name of 'frostings,' which are readily laid hold of by the gum; and the glass thus prepared I attach to the stained, or painted, or other figured glass on the inside, or that side which is next to the interior of the house or building, by means of gutta percha solution, or some other suitable cement, applied to the edges. The frostings have on the inside the effect of giving a beautiful lustre to all the lighter parts of the design on the stained, or painted, or other figured glass, without impairing in the least the strength of tone of the darker or coloured portions; while they impart to the glass, when viewed from the outside, much the same effect as if a flood of light were streaming through from within."

In all the other different modes proposed for decorating houses by the patentee, the plan of giving a glass surface is adopted so as to produce the effect of a most brilliant polish, and at the same time to serve as a protection against damp and atmospheric corrosion.

ECONOMY OF FUEL IN STEAM-FURNACES.

Felix Douche, of Rouen, France, merchant, for "*certain means, processes, and apparatus used for saving and applying the lost heat in general, and sometimes direct heat, to many useful purposes.*" (A communication.)—Granted February 10; Enrolled August 10, 1848.

This invention relates, first, to an improvement in the feeding apparatus for supplying the feed-water to steam-boilers, and is constructed as follows. A number of tubes or pipes are placed in a vertical position within a cylindrical vessel, the ends of the tubes being secured to two chambers, one at each of the ends of the tubes, the interior of the tubes forming a communication between the chambers, which have no communication with the exterior of the tubes; there are two communicating pipes from the cylindrical vessel, one at the top and the other at the bottom; there are also pipes of communication from the two chambers. The upper pipe of the cylindrical vessel communicates with the boiler, and the lower with the feed-pump; thus the supply of feed-water will pass through the cylindrical vessel amongst the tubes, and take up the heat given off by the waste steam, which is passed through the tubes and chambers for that purpose. The second improvement consists of a slight modification of the above, for the purpose of heating air by passing steam or fire through the tubes, the air being in contact with the exterior of the tubes; the patentee gives this apparatus the name of ærifor or caloridor. The third improvement relates to a stretching apparatus for stretching the tissues or fabrics as manufactured by machinery. The fourth improvement consists in allowing the waste steam to flow through a pipe into a large square receiver, where it is condensed. The fifth improvement consists in the application to external surfaces, for the purpose of retaining the heat therein, of envelopes or wrappers.

TURN-TABLES.

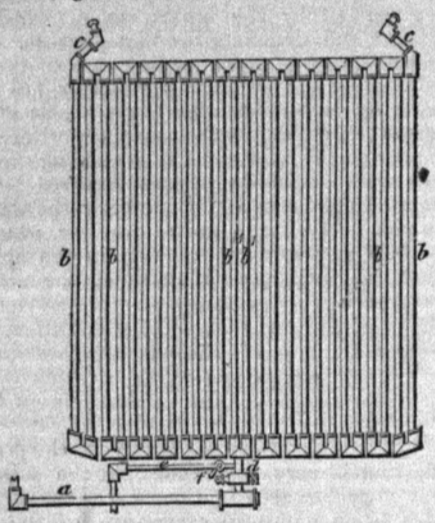
William Thorold, of Norwich, engineer, for "*Improvements in turn-tables.*"—Granted January 13; Enrolled July 13, 1848.

This specification is very voluminous, as the patentee claims eleven different improvements in the construction of turn-tables. The first relates to an improved centre-pin, which improvement consists in forming on it a projecting flange or collar, the upper surface of which is an incline or snail piece on which the centre of the table rests. The upper part of the pin has a ratchet-wheel attached, which is level with the surface of the table, and fitted with a click or pall attached to the table, which prevents it turning round without the table, while, at the same time, the ratchet and pin may be turned round by inserting a spanner in two holes in the upper side of the ratchet, the incline plane at the lower end raising the table when such elevation is required. Secondly, the patentee claims a mode of constructing the centre squares of the top frame, having the rails laid thereon, and independent of the other part of the frame-work. Thirdly, different modes of constructing and arranging the working rollers that form the support of the circumference of the turn-tables. Fourthly, a method of diverting the dust, rain, and all extraneous matters, and also for clearing away such extraneous matters from the circumference. Fifthly, a mode of constructing turn-tables without centre-pins, and, consequently, without the usual parts connected with centre-pins and other bearings. For this purpose he employs beams or girders of a stronger description than usual, for supporting the rails and platforms of tables of a corresponding size. These girders being attached at each end to the upper bearing-surface of the circumference, which is supported on rollers as usual from the under surface. The axes of these rollers instead of being attached to a separate frame revolving round the centre-pin, have their axes placed between two concentric belts or rings, which maintain the position of the rollers in a circle equal to the diameter of the bearing-surfaces. The under bearing-surface has its inner circumference rendered truly circular, and forms a surface on which horizontal guides or friction-rollers travel. These rollers are supported from axes pendent from the under-side of the table, and consequently maintain the position of the table concentric with the bearing-surfaces. The sixth improvement consists in a mode of constructing the top frame in several divisions or compartments, and of various kinds of material. The seventh claim is for the exclusive privilege of casting the bearings and all working parts of turn-tables on chills, the same never having been heretofore practised. Eighthly, the method of constructing single-line tables in such a manner as to render them more economical than such tables have hitherto been. Ninthly, the constructing larger kinds of turn-tables, with moveable joints in the beams or girders which support the rails; also for the more perfect mode of stopping such tables at the proper point for effecting a junction with the line of rails. Tenthly, a method of constructing the larger kinds of turn-tables, so that the power of a locomotive can be applied to the turning of such table when it is loaded with the engine and its tender, and when they require reversing on the line of rails. Lastly, the patentee claims a method of raising and locking the centre of turn-tables, when they require to be turned.

STEAM-BOILERS.

Horatio Black, of Nottingham, lace-maker, for "*improvements in evaporation.*"—Granted February 14; Enrolled August 14, 1848.

This invention relates to a mode of supplying water to steam and other boilers, by passing it through a succession of hollow fire-bars, of wrought-iron, brass, copper, or malleable cast-iron, previous to entering the boiler.



The annexed engraving is a plan of a set of fire-bars. *a* is the supply-pipe, through which the water is forced into the tubular fire-bars, *bb*: the water first enters the middle bars $b^1 b^1$, and, after circulating through the whole series of bars, passes, in a highly-heated state, through the pipes *c c*, into the boiler. It is not essential that the water should be divided into two streams, as the whole supply may enter into one bar, and circulate through the series of bars in the same direction; or more than two divisions of bars may be used in large furnaces. *d* is a cock on the supply-pipe, to regulate the quantity of water admitted. *e* is a pipe, furnished with a cock *f*, which is to be opened when the supply of water to the boiler is not going on; as otherwise the heat of the fire would tend to force the water out of the tubular bars; but by the cock *f* being opened sufficiently to permit the escape of a small quantity of water, such a circulation will be kept up as will prevent the water being driven out of the bars *b b*, when the supply of water to the boiler is stopped.

The above arrangement is suitable either for high or low pressure boilers; but, generally, for low-pressure, a rising pipe is attached, with a small cistern at the upper part, to the supply-pipe *a*, near the force-pump; and a valve is placed over the opening through which the water enters the cistern;—"the valve preventing the water from flowing from the cistern to the boiler, by the valve being weighted, causes a pressure sufficient to force the water into the pipe *a*, and thence through the hollow bars *b b*, into the boiler; the quantity admitted to the boiler being regulated by the cock on the pipe *a*." By means of this arrangement, the water, forced into the pipe *a*, will flow into the boiler so long as it is required; but any excess will pass up the rising-pipe into the cistern, which is provided with an overflow-pipe: the boiler will thus work, at all times, subject to the pressure of the column of water in the rising-pipe and cistern. It should be stated that there is a valve in the pipe *a*, between the rising-pipe and the force-pump; which valve opens towards the boiler, and permits the water to flow in that direction, but closes against any flow of water from the boiler.

REVERBERATORY FURNACES.

James Timmins Chance, and **Edward Chance**, of Birmingham, for "*Improvements in furnaces, and in the manufacture of glass.*" Granted February 14; Enrolled August 14, 1848.

This invention, as the title imports, relates to improvements in two distinct departments of the manufactures. The first, which refers to reverberatory furnaces, has for its object the greater economy of fuel, by re-conducting the heated gases to the furnace. In the usual construction of such furnaces, the heat from the fire, after striking against the arch above the furnace, and being reverberated downwards, passes off to the chimney. The patentees, instead of thus passing the heat direct into the chimney, render it further available to heating the furnace by returning the flue and carrying it back over the reverberating arch, and then downwards and to the chimney, whereby the heat in passing through the return-flue is reverberated downwards upon the top of the reverberating arch of the furnace itself, and thus assists in heating that portion of the furnace. The second part of the invention consists in a mode of passing sheets of glass into annealing furnaces or kilns. By the ordinary method the glass to be annealed is pushed into the kiln, and before this can be done the glass must lose a great portion of its heat, to enable it to possess sufficient firmness and solidity to bear the pushing strain to which it is subjected. The patentees make in the side wall of the furnace opposite to that where the entrance for the sheets of glass into the furnace is situated, a hole or opening through which the workman passes an instrument which, passing across the furnace and taking hold of the edge of the sheet of glass, pulls and draws it into the kiln; by this mode the temperature may not be so much reduced as when the old mode of pushing is adopted, inasmuch as the strain attending the pulling is considerably less than that of pushing.

RAILWAY-BREAKS.

Robert Heath, of Heathfield, Manchester, gentleman, for "*certain improvements in the method of applying and working friction breaks to engines and carriages used upon railways.*"—Granted January 13; Enrolled July 13, 1848.

The object of this invention is to bring a heavy weight, attached to a lever, to bear against the friction break, so as to render the action more certain and regular than when manual force alone is exerted. The lever is placed under the control of the guard, who, by turning a winch placed in the ordinary manner, may bring the weight to bear upon the peripheries of the wheels, or remove it, with very little effort.

Samuel Cunliffe Lister, of Manningham-hall, Bradford, gentleman, for "*improvements in stopping railway trains and other carriages, and generally where a lifting power or pressure is required.*" Granted January 18; Enrolled July 18, 1848.

In this railway-break the resisting force is atmospheric pressure, or the pressure of compressed air, bearing against the breaks, which, as usual, act on the circumferences of the wheels. The apparatus consists of an air-chamber, placed below the framing of the carriage. It is provided with a piston or pistons, to the rods of which are attached the blocks, bearing against the wheels. The air is condensed into the air-chamber by air-pumps, worked by the axles of the carriages; and, by means of the pistons and rods, the pressure is communicated to the wheels. The mode to be adopted when the breaks are required to be thrown into action, is for the guard, by means of suitable connecting apparatus, to open the valves, by which means the atmospheric air will be admitted to the pumps, a few strokes of which will then so compress the air within the receiver as to press the breaks against the wheels. Similar effects are produced by making the pumps act as exhausters, instead of compressers.

RAILWAY KEYS.

William Henry Barlow, of Derby, civil engineer, for "*Improvements in the manufacture of railway keys.*"—Granted January 27; Enrolled July 27, 1848.

In these improved wooden keys, the inconvenience arising from expansion and contraction is attempted to be obviated, by rendering the wood impervious to moisture. This is done by introducing into the pores of the wood, fatty or other matters that are insoluble in water. The patentee first prepares the keys of the requisite proportions, after which they are subjected to heat for the purpose of expelling the moisture. This he effects by placing them in an oven for 24 hours, which is maintained at a temperature of 212°, after which they are immersed in a solution by preference composed of four gallons of creosote, one gallon of naphtha, 24 lb. of pitch, and half a gallon of boiled linseed oil. The proportion of this mixture used to impregnate the wood is about one gallon to the cubic foot, and the keys should be immersed therein about 24 hours. They are then ready for use, unless it be deemed necessary to subject them to the process of compression. Instead of simple immersion in these insoluble matters, the process may be greatly facilitated by exhausting the air from the wood in a close vessel, and afterwards forcing the fat composition in under pressure.

IMPROVEMENTS IN MARINE ENGINES AND PROPELLERS.

JOSEPH MAUDSLAY, of the firm of Maudslay, Sons, and Field, of Lambeth, engineers, for "*Improvements in obtaining and applying motive power and in the machinery and apparatus employed therein.*"—Granted March 8; Enrolled September 8, 1848. [Reported in the *Mechanics' Magazine.*]

Fig. 1.

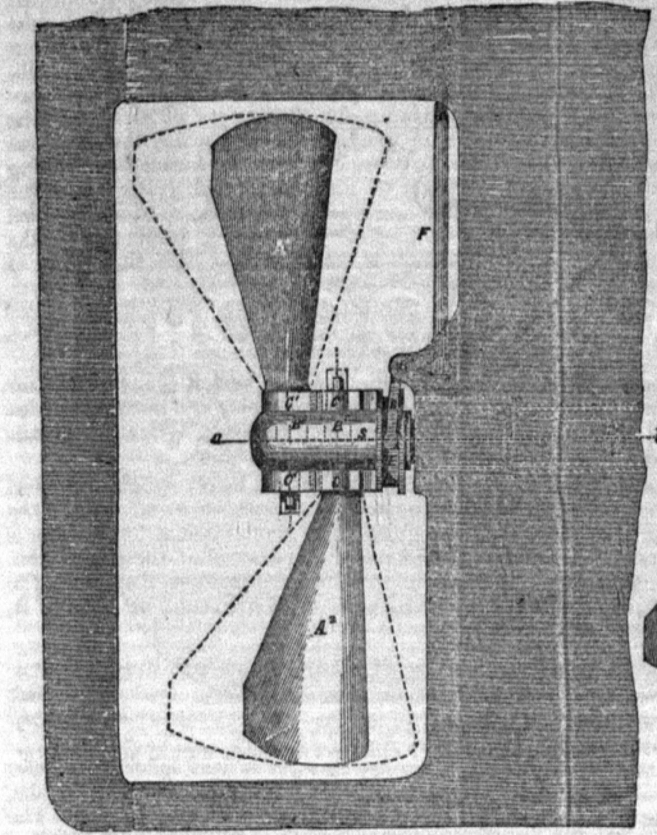


Fig. 2.

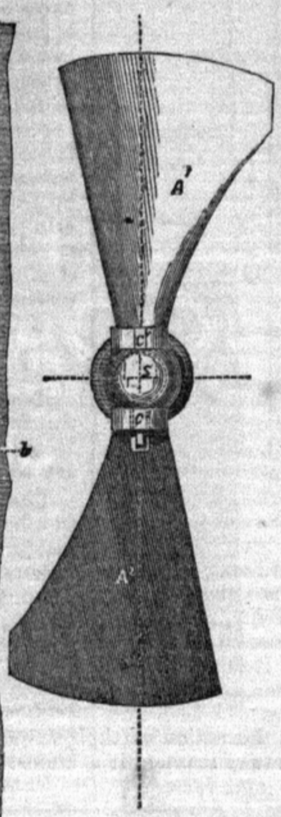


Fig. 3.

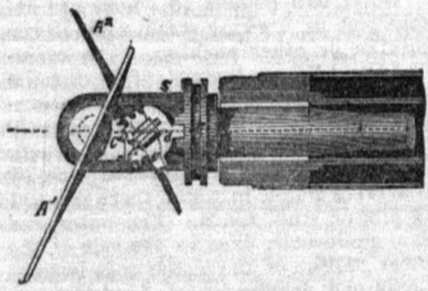


Fig. 4.

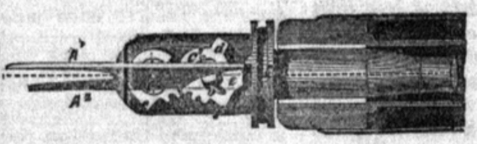
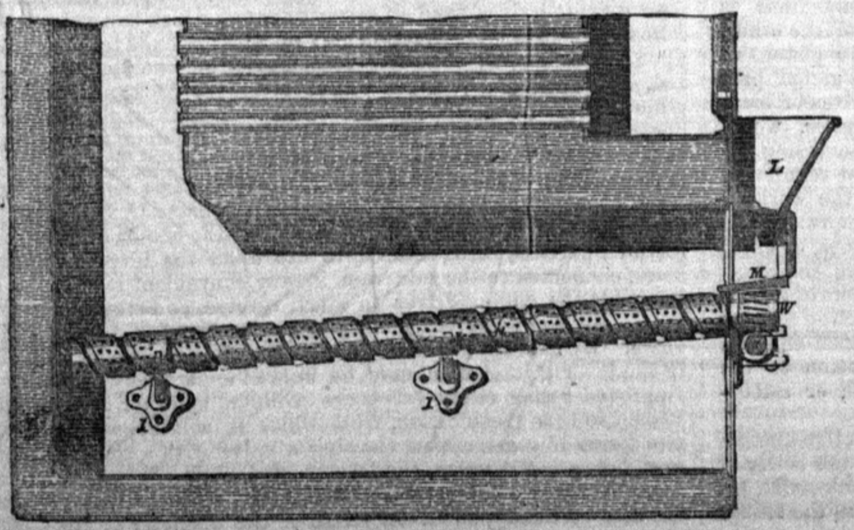


Fig. 5.



1. The new steam propeller which forms the leading subject of Mr. Maudslay's present patent, obviates one of the greatest obstacles that have hitherto stood in the way of steam propelling, whether by means of screw blades or flat blades, or blades of any other description; viz., the difficulty of shipping and unshipping the propeller. Mr. Maudslay affixes the blades of his propeller (which may, he says, be of "any approved or suitable form") in such a manner to the driving-shaft that the propeller assumes of itself, as it were, the proper angle for propulsion, the instant the driving-shaft is put in motion, and returns as instantly into a neutral or inoperative position when the driving-shaft ceases to rotate.

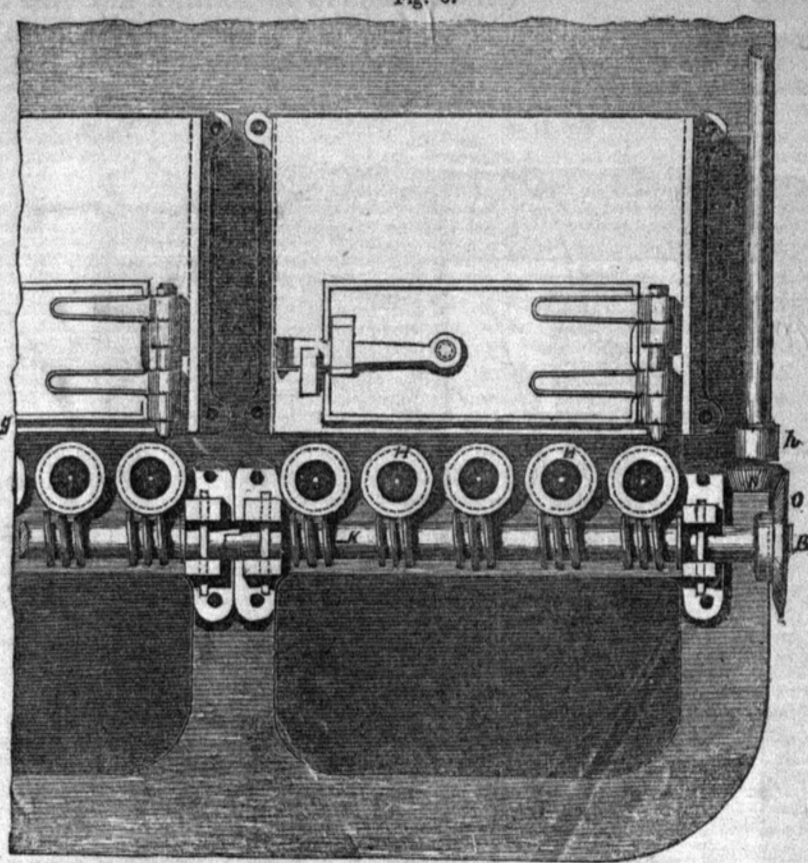
Fig. 1 represents part of the stern of a vessel fitted with this improved propeller; fig. 2, a front view of the instrument detached from its place in the vessel; and fig. 3, a sectional plan of the propeller, and its connections on the line *a b* of fig. 1.

"A^1 A^2 are the blades of the propeller, which are inserted at their inner or narrow ends into sockets B^1 B^2, in the end of the propeller-shaft S, in which sockets they are free to turn to the extent to be presently defined. To the shank of each propeller blade there are two toothed segments C^1 C^1, C^2 C^2, attached one at the top of each socket, and the other at the bottom of it; and the two sets of segments work the one into the other within the limits determined by the stops *f f*, so that the propeller-blades must always move in perfect unison, and can only turn round in their sockets to the extent allowed by the stops. E is a sliding clutch, affixed to the driving-shaft inside of the propeller-blades, which may be moved sternwards, so as to lay hold of either of two sets of pins, *d d* and *e e*, which project from the back of the wheels of the innermost propeller-blade A^2. F is a vertical rod, by means of which the clutch E, may be worked from the deck of the vessel; this rod terminating at bottom in a screw, which takes into a swivelled nut *n*, which is attached to one arm of a bell-crank G, the other arm of which is forked so as to embrace the clutch E, when brought down upon it. The mode in which the propeller, as thus fitted, acts, is as follows:—Supposing the clutch to be disengaged, and the driving-shaft to be put in motion, the blades are immediately thrown out into the angular positions proper for propelling, and they will continue in these positions as long as the shaft continues to rotate. Should occasion arise for backing the vessel, the blades are then secured in their extended positions by interlocking the clutch with the pins *d d*, at the back of the wheels of the innermost blade A^2, as represented in fig. 3. When the engine is stopped, and the driving-shaft ceases to rotate, and the clutch is withdrawn, the propeller-blades will, by the action of the water upon them, be turned round in their sockets until they come into a line with the course of the vessel, and present their sharp edges only to the water, as exemplified in fig. 4; and, for greater security, they may be made fast in this position by interlocking the clutch E, with the pins *e e*, at the back of the wheels of the innermost blade."

From the instantaneousness with which this peculiarly fixed screw propeller can be turned to account, from its never being required to be raised out of the water, and never offering, when in the water and at rest, any material obstruction to the steering or progression of the vessel, it seems to possess so far a great superiority over all the screw propellers hitherto in use; but it promises to be more especially advantageous in the case of vessels going long voyages, with small store of fuel, and employing steam as an auxiliary power only, when the wind is not fair for the use of sails. With a propeller of this description, not a minute need be lost in changing from sailing to steaming, or from steaming to sailing, and consequently, not a pound more of fuel need be expended than is absolutely required.

2. The peculiar feature of Mr. Maudslay's new furnace consists in the employment of rotating tubular screw bars, and hence the the name ("Archimedian") by which we (not Mr. Maudslay) have ventured to distinguish it. Fig. 5 is a longitudinal section of the furnace; and fig. 6 a front view.

Fig. 6.



H H, are the fire-bars, which, instead of being as usual solid fixtures, consist of a series of tubes which are free to revolve in their bearings, are open from end to end, screw-threaded on the outside, and perforated with numerous air-holes. On the front end of each bar there is a broad flange or shoulder *f*, which projects beyond the general line of the furnace, and has a worm-wheel W, formed upon it. An endless screw-shaft K, which passes across the front of the furnace, and is worked from the engine through the medium of the bevil-wheels N, O, takes into the whole series of worm-wheels W, and causes thereby the constant rotation of the fire-bars. L is a throttle-valve hopper by which the coals are supplied to the furnace. As the coals drop from the hopper they fall upon an inclined shoot M, which projects them upon the front end of the furnace bars, whence they are carried gradually forward to the back, by the rotation of the bars and the action of their screwed surfaces on the mass of fuel.

In consequence of the bars being in this constant state of rotation it is almost impossible that either clinkers or ashes should accumulate upon them.

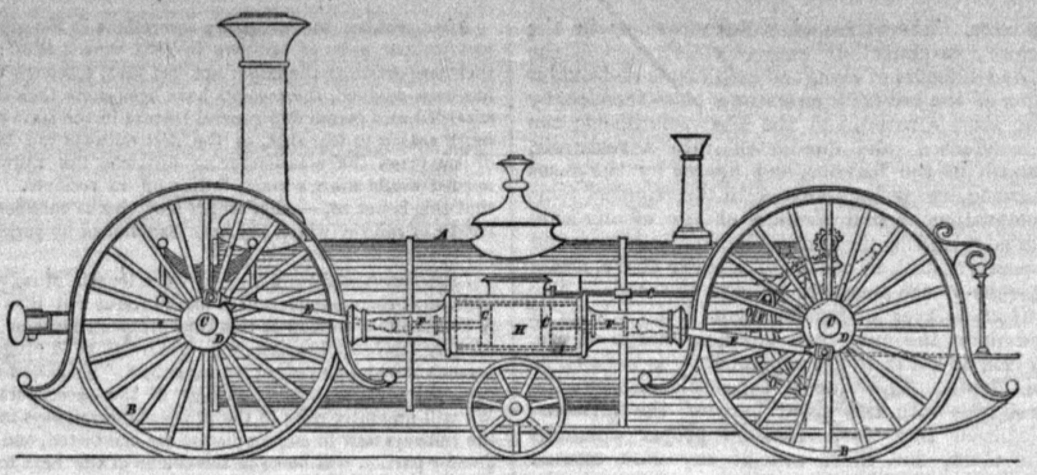
LOCOMOTIVE ENGINES.

Charles Ritchie, of Aberdeen, Scotland, engineer, for "*certain Improvements in locomotive engines.*"—Granted March 2; Enrolled September 2, 1848. [Reported in the *Mining Journal.*]

This invention consists in, and has reference to, certain improvements in locomotive and other engines, carried into practical effect by the means, or through the agency, of certain new or improved mechanical combinations and arrangements, having for their object the simplification of the construction, and the augmentation of the efficiency, of such engines.

The first part consists in the application of a cylinder, or cylinders, with two distinct and separate pistons in each cylinder, to which are affixed piston-rods, for imparting motion to the cranked-axles and driving-wheels fixed thereon, whereby the rocking, or oscillating, motion attending locomotive engines as hitherto constructed, is considerably diminished, and greater steadiness of motion obtained, as, by this arrangement, the momentum of one piston, together with its cranks, and other connections, is at all times exactly balanced, or nearly so, by that of the other, in consequence of the approaching or receding of the pistons to and from each other being always simultaneous. The second part relates to an improved mode of working the slide-valves of locomotive and other engines, by rendering the eccentric, which imparts motion thereto, available for the purpose of reversing the engine. The third part relates to an improved valve for regulating the admission of steam, or other motive power, to the working cylinders of locomotive and other engines, and to improvements in safety-valves, to be applied to the boilers of engines, or other reservoirs of power. The fourth part relates to an improved anti-primer, or steam-collector, to be applied to the boilers of steam-engines. The fifth part relates to an improved self-acting feeding apparatus, for supplying water to the boilers of steam-engines. And the sixth and last part consists in the application to the wheels of locomotive engines of an improved guard, or safety-break.

The drawing exhibits a side elevation of a locomotive engine, constructed according to this invention. A marks the boiler of the engine; B, the driving-wheels fixed upon the crank-axles, C; the boss, or nave, D, of each of such wheels serving as the crank, to which one end of the connecting-rod E, is attached by a crank-pin, or stud, *a*, secured to the said nave, and the opposite end of the rod E, is connected to the piston-rod F, in the usual way of forming such connections. G, G, two pistons, to which are attached the rods F, F—the said pistons working steam-tight in the cylinder H, by means of metallic, or other packing. The cylinders are fixed to each side of the boiler. Instead of having the fixed cylinder and connecting-rods, as above described, oscillating-cylinders may be used, with their piston-rods connected directly with the crank-axle; or where fixed cylinders are used, and space is an object, the connecting-rods E, E, may be dispensed with, by attaching to the piston-rods a cross frame, in which there is a slot formed, into which a crank-pin, or stud, takes. The outer end of the frame works through a guide-hole, fixed to the side of the engine, and thus the rectilinear motion of the piston-rods imparts rotary motion to the crank-axle and driving-wheels fixed thereon. The steam may be admitted through the ports, into the cylinder, by a common slide, in the following manner:—Upon the hindermost driving-axle is fixed an eccentric, upon which is a cam, of the following peculiar construction:—Two rods are fixed to, or formed upon, the said cam; or it may be composed of one double-gabbed rod, one gab being employed for effecting the backward, and the other the forward, motion of the slide-valve, through the intervention of a double lever, which has its fulcrum upon a stud, fixed to the side of the boiler, as shown by the drawing, and this lever is connected to the slide-valve by a rod *c*. The length of this lever, as also the angle of inclination of the parts O, O, should be in accordance with the lead of the valve—the one or other of the inclined parts O, being caused to act upon the lever by a hand lever, connected to the said cam in any convenient manner, so as to enable the engine-driver to start, reverse, and stop the engine readily, by the same eccentric which gives motion to the slide-valve. By making the end of the valve-rod moveable, as in a slot in the lever P, the steam may be worked expansively at pleasure. Improved spring safety-valves are exhibited by other drawings attached to this specification, from which it will appear there are two forms of construction, showing a valve with a conical-shaped seat, being a flat-valve, and constructed with a flange, which the inventor terms a compensation flange—such flange being let into the seat vertically, about one-sixth of the diameter of the steam-



way in the valve-seat. This valve is weighted by a helical spring, of sufficient power, according to the required pressure of the steam; and when it is intended to be used as a reserve safety-valve, the spring is to be placed around that part of the stem below the valve—that is to say, within the boiler. The advantage of this form of construction of valve over the ordinary valve is as follows:—As soon as the pressure of the steam raises the valve from its seat, the flange, being exposed to the pressure of the steam, presents an increased surface, which compensates for the increasing resistance of the helical sping, until the valve has been raised to a height equal to the area of the steam-way, when it allows the steam, or vapour, to escape freely. When not intended as a reserve safety-valve, this valve may have the spring placed above it. Another valve, which is called an indicator safety-valve, is exhibited, consisting of a piston, which is fitted into a tube, having a spring attached to it—lateral openings being made in the tube, to allow the steam to escape when the piston becomes raised above such openings; and by making the said tube moveable within another one, the "blowing-off" point may be varied at pleasure. An index, like that of a barometer, may then be attached to the stem, or rod, of the piston, and will indicate very slight variations of pressure. A regulating-valve is attached, the construction and arrangement of which is as follows:—There is a short socket-pipe, having two conical valve-seats formed therein, into which the valves fit—such valves being connected together, or formed upon one stem, into which one end of a rod is screwed, or otherwise made fast, and the opposite end of the said rod attached to an eccentric spindle, working through a stuffing-box, to which a hand-lever is fixed—such lever and rod being for the purpose of opening, or closing, the regulator-valve at pleasure.

The anti-primer before-mentioned is formed in the following manner:—Two distinct and separate plates of sheet metal, the outer edges of which are securely fixed to the inside of the boiler, by rivetting, or otherwise, the said plates being inclined towards the centre of the boiler, care being taken to leave a space between the inner edges of the two plates, so as to reserve a channel lengthwise of the boiler, for the passage of steam into the steam-chamber thus formed, and within, or in connection with which the regulating-valve, is situate the steam-pipes which lead to the cylinders being connected thereto. Instead of forming the anti-primer of two separate strips, or pieces, of metal, the same result may be obtained by forming it of one strip, or piece, of metal, of the shape shown—the said plate being pierced with an infinite number of small holes. The construction and arrangement of the feeding-apparatus are as follows:—There is a metal cylinder, which should be bored perfectly true and cylindrical, fitted with a piston, the rod of such piston forming the plunger, or ram, of the cold water pump, the barrel of which serves as a compound gland for the stuffing-box of the cylinder and pump-barrel. The slide-valve, which may be made to cover or uncover the ports, or passages, in the cylinder, by the opposite sides of the piston coming into contact with the levers, which are connected to the slide-valve by a rod or rods. There are spherical-valves (the seats of which are knife-edged), formed within the spherical flange pieces, which have openings for establishing a communication between the tender, the pump-barrel, and the steam-boiler, as exhibited. The *modus operandi* of this feeding-apparatus is as follows:—Upon steam being admitted from the boiler into the cylinder, through the steam-port, or passage, the piston will be acted upon, and the ram, or plunger, be withdrawn, the water from the tenders will raise the valve, and enter the barrel, to supply the space previously occupied by the plunger, or ram; by this time the piston will have acted upon the lever, so as to cause the slide-valve to uncover the port, or passage, and cover the port, or passage, P_1, thereby allowing the steam on the other side of the piston to escape through the exhaust-pipe; the piston will now be impelled in a contrary direction, and the plunger, or ram, entering the barrel, will cause the one valve to be closed, and the other to be opened by pressure of the water therein, which as the plunger, or ram, advances, will be forced into the boiler, to supply the deficiency of that water which has been converted into steam; R_1, R_1, mark wheel-guards, or safety-breaks, which are each composed of a strong band, or strap, of iron, placed like a splasher over the wheel to be protected; the inner surface of the said guard, or break, is formed of the converse shape to that of the tyre, and fixed securely to the framing, or boiler, or both, as near to the top of the wheel as the play of the bearing-springs will admit of, and as near to the back of each wheel as possible, without touching it.

To each side of the engine a bar of iron is placed, and securely fixed in a longitudinal direction—such arrangement being intended to preserve such wheels in a vertical position, and thereby support the engine, in the event of the axles breaking, and to operate at the same time as a break, to retard the motion of the engine, in the event of any such accident. Another improvement in locomotive engines consists in arranging that part of the boiler known as the fire-box, in such manner that the height of the water in this part of the boiler shall at all times be at a proper level, which is effected by what is called an anti-fluctuator, which is a separate partition-plate across the water space, or an extension of the plate to which the tubes are fixed as shown; and, by causing the water to be fed to the boiler at that part which surrounds the fire, it will appear evident that the barrel of the boiler can only receive its supply of water from that which overflows the said partition-plate. Having described the nature of his invention, the patentee remarks, that he does not claim the exclusive use of any of the separate parts above-mentioned and referred to, when considered *per se* and apart from the purposes of the said invention, as hereinbefore set forth and described.

IMPROVEMENTS IN PERFORATING GLASS FOR VENTILATION. Patented by Mr. J. LOCKHEAD, of Milton, Gravesend.—In forming plates, sheets, lenses, or other forms of glass, the glass, when in a semi-fluid state, is poured from the pot on to the casting-table—the stream being followed by a pressure-roller, for the purpose of flattening it; and, while the glass is in a plastic state, a metal mould, with teeth or projections on its under-side, according to the pattern required, is applied to the surface, forcibly pressed down, and left in that position until the glass has set; after which it is to be removed, and the glass will be found to be perforated, in corresponding shapes to the projections on the mould. To effect this in the most complete manner, a screw-press, made to the size of the casting-table, is used, very similar to a common copying-press, and different pattern-moulds being fixed to the lower end of the screw, and worked by a cross handle.

IMPROVEMENTS IN OBTAINING OXIDE OF ZINC FROM THE ORE. Patented by M. C. A. F. ROCHAZ, of Paris.—By this process, the employment of retorts, as by the old method, is dispensed with, the fuel and labour economised, the operation completely independent of the skill of the workman, and the loss of metal, incidental to the old method, prevented. Ores of lead and zinc may be operated on at once. The principal feature consists in the reduction of the native sulphuret of zinc (blende), and of the carbonates, oxides, and silicates of zinc, and sulphurets and oxides of lead, by the action of the reducing gases of a blast-furnace, by which the scoria, or slag, is fused, and the zinc volatilised; the vapours are then condensed, and conducted into a reservoir, situated over the mouth of the furnace, and heated by the gases therefrom. The furnace having been heated to the required temperature by the combustion of fuel alone, a charge of any kind of the above zinc ores, mixed with a suitable flux, is introduced into the charging aperture, and, by means of a cover above, and a sliding plate below, none of the gases are allowed to escape. The charge thus falls upon a layer of incandescent fuel; a layer of fuel is then poured upon the ore; then another charge of ore, until the furnace is full, and it is to be replenished as the charge sinks below a certain depth. The zinc is thus volatilised by the heat, and the scoria falls into the lower part of the furnace; the gases and volatilised zinc pass through proper openings through a hydraulic main, and there deposit any zinc carried with them.

BRITISH ASSOCIATION.

Reports read at the Meeting held at Swansea, August, 1848.

Railway Statistics.

"*Facts bearing on the Progress of the Railway System.*" By Mr. W. Harding.

The modern railway system of Europe may be said to date from 1830, when the construction, by Mr. G. Stephenson, of the Liverpool and Manchester Railway, with its locomotive engines, was completed. After that date we heard no more of such prophecies as the following (from the *Quarterly Review*, in 1825), which it is not useless to record as a lesson of caution to us for the future:—"As to those persons who speculate on making railways generally throughout the kingdom, and superseding all the canals, all the wagons, mails, and stage-coaches, post-chaises, and, in short, every other mode of conveyance by land and by water, we deem them and their visionary schemes unworthy of notice. What, for instance, can be more *palpably absurd and ridiculous* than the following paragraph,"—in which a prospect is held out of locomotives travelling twice as fast as stage-coaches. "We should as soon," adds the reviewer, "expect the people of Woolwich to suffer themselves to be fired off upon one of Congreve's ricochet rockets, as trust themselves to the mercy of such a machine, going at such a rate." The modern railway system has, however, not only done this, but it has given rise to new habits in the present generation, and has proved to be the great mechanical invention of the nineteenth century, as the steam-engine was of the eighteenth. As it is still in its infancy, it is especially the province of statistical inquiry to watch its growth, so that on the one hand timely remedies may be applied to its defects, and on the other free scope may be given to its beneficial tendencies. Valuable papers have been contributed by Messrs. Laing, Porter, Graham, and others, analysing the traffic on railways during the infancy of the system to the year 1843. Shortly before that period there had been a pause in railways. During two years, only five miles had been sanctioned, but the period which has since elapsed comprises the memorable mania years of 1845 and 1846. Under this excitement intelligence and emulation have been stimulated among the managers of railways to the utmost, and the system has rapidly advanced. The consolidation of lines under a few great companies, by the process styled amalgamation, has proceeded;—the atmospheric, an entirely new system of traction, has been brought forward;—the electric telegraph, conveying intelligence at the rate of 280,000 miles a second, has been widely introduced;—express trains, travelling at nearly the highest attainable speeds, have been established,—and the length of railways in operation has been doubled. It therefore becomes a matter of interest to inquire to what the results of so active a period point. Have low fares answered?—Has the third-class traffic, the most important to the bulk of the people, been encouraged, and has it been found wise, not only for the users but for the owners of railways, to encourage it or the reverse?—Has the increase of speed been successful, and are we likely to travel faster or slower hereafter?—How have the receipts kept up while the length of railway has been doubled?—Did the first 2,000 miles get the cream of the traffic, as has often been thought, and has the average receipt per mile consequently fallen off?—Should the experience of the past, in short, give us confidence in urging on the system at the extraordinary rate at which we are now doing it, or not? In the following investigation and collection of facts it has been attempted to throw some light upon these points;—the recent publication of the official railway returns for 1846 and 1847 affording peculiar facilities for the purpose. The following paper refers to English, Scotch, and Welsh lines only,—the Irish lines are excluded, the economical condition of Ireland being different from that of this country, and there being but few railways open in that country:—

Comparative Lengths of Railway open in 1843 & 1847 *and Receipts thereon.*

The lengths of English, Scotch, and Welsh railways open June 1843 were	1,990
Ditto, open at the commencement of 1848	3,597
The gross receipts returned for the year 1842 were	£4,740,000
Ditto, for the year ending June 30, 1847	8,366,772

After making the necessary corrections in the above figures, the average receipts per mile of railways in 1842 were 2,489*l.*; in 1847, 2,596*l.* We therefore arrive at the important fact that, although the mileage of our lines has been doubled, the receipts have been more than doubled. This must be regarded as a favourable general feature in the state of railways. There was much reason to fear that, as the first railways ran between the great towns or traversed the manufacturing districts, the railways which were next opened would show a great falling off in receipts. Hitherto, then, we find that this is not so,—a fact which may give us confidence as regards the great length of railway which has been sanctioned by parliament but which is not yet open.

Lines sanctioned but not open.—The length of railway sanctioned by parliament at the commencement of 1848, but not then open, was 7,150 miles. A considerable portion of this is in progress, more or less rapid. On the 1st of May 1847, 5,209 miles were returned as in progress, on which 218,792 persons were employed, or 42 per mile.* These new railways are principally designed for the accommodation of the agricultural parts of the country. We will presently refer to the prospects of railways in such districts. When the railways now in contemplation are completed, and it is probable that the greater portion will be so in the course of the next five years, we shall have upwards of 10,000 miles of railway open,—on which, judging from the numbers employed on lines now open, (viz., 14 per mile), 140,000 persons will be permanently employed, at good wages,—representing, at five to a family, three quarters of a million of the gross population. The importance of this addition to our internal communications will be appreciated when it is remembered that there are only about 4,000 miles of inland navigation and 30,000 miles of turnpike road open for traffic in the country.

Analysis of Traffic.—General Features.—The gross traffic for the year ending June 30, 1847, was, as we have seen, 8,366,000*l.* There were conveyed during that year, from the returns of the Board of Trade,† in round numbers, 7,000,000 tons of merchandise and goods, 8,000,000 tons of coal, 500,000 horned cattle, 1,500,000 sheep, and 100,000 horses.

Of the gross sum, 8,366,000*l.*, the passenger receipts were ..	£5,024,000
The receipts from all other sources—goods, cattle, carriages, parcels, mails, &c.	3,342,000
Total ..	£ 8,366,000

In every 100*l.* of receipts, the passenger traffic therefore forms 60 per cent., the traffic receipt from other sources 40. In 1842 these proportions were as 64 to 36. The proportions of traffic receipts from other sources than passengers (being principally goods and cattle traffic) have thus increased since 1842 as 40 to 36, or 11 per cent. The total number of passengers carried in the year (ending June 30) 1847 was 47,484,134, as compared with, in 1842, 22,403,478. The average distance travelled by each passenger was, in 1842, 13 miles; in 1847 it was 16 miles. The numbers and proportions of classes were

	In 1847.	In 1842.
First-class	14·2	20·2
Second-class	38·3	45·4
Third-class	47·5	34·4

Thus, the third-class passengers (which have increased in number since 1842, from 6,000,000 annually to 21,000,000,) now form nearly half of the whole number travelling, whereas in 1842 they formed only about one-third. Only one-third of the third-class passengers have availed themselves of the parliamentary trains, arbitrarily (and, as it appears to me, unfairly) imposed upon railway companies in 1844. The following table, comparing the fares of the metropolitan railways in the year ending June 1843, with those in the year ending June 1847, shows the great reduction which has taken place in fares during the last four years. To make the comparison more appreciable, the fares are taken as for 100 miles in pence.

Name of Railway.]	Fare for 100 Miles.					
	1st Class.		2nd Class.		3rd Class.	
	1843.	1847.	1843.	1847.	1843.	1847.
London and North-Western ..	334·8	218·1	241·1	144·6	131·2	93 3
Great Western	303·1	274·4	208·5	187·8	118·3	100·0
London and South-Western ..	312·0	245·0	210·0	168·0	120·0	96·0
Eastern Counties	294·1	210·0	227·4	141·5	164·7	92·3
Northern and Eastern ..	217 4	—	165·	—	110·9	—
South-Eastern	227·0	214·0	150·0	152·0	87·5	90·0
London and Brighton ..	350·0	263·0	225·0	171·0	150·0	109·0
Average	303·5	237·4	210·3	160·8	128·6	96·7
Difference per cent. ..	—	21·8	—	23·8	—	25·0

This reduction in fares, coupled with the increase in the number of trains, and the speed of travelling, must be regarded as the principal cause of the great increase of the number of passengers since 1843.

We have already seen that the numbers in 1847 and 1843 are as 47,484,134 to 22,403,478. If we take into account the number of miles opened at those dates respectively, the annual number per mile was, in 1842, 11,772, and in 1847, 14,806.

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* In this return the number of miles returned as in progress are more than those really in construction, the number of men employed per mile is less than the truth.

† These returns are not complete, and they require some correction, in respect of the same articles being sometimes conveyed over several different lines, and therefore counted over more than once.

The proportion of third-class passengers has, we have seen, thus satisfactorily increased between 1842 and 1847. The third-class traffic has, however, developed itself very differently on different lines; and it may be well to inquire into this. The statement subjoined shows the third-class traffic of two metropolitan companies (the Eastern Counties and the Great Western)—two North of England companies (the Lancashire and Yorkshire and the Newcastle and Berwick)—and two Scotch companies (the Edinburgh and Glasgow and the Glasgow and Greenock).

Year ending June 30, 1847.

Name of Railway.	Length in Miles.	Number of Third-class Passengers conveyed.	Proportion in every Hundred of Third-class Passengers.
Glasgow, Paisley, and Greenock ..	..	957,5"4	83·3
Newcastle and Berwick ..	65½	944,891	79·5
Edinburgh and Glasgow ..	46	836,025	72·8
Lancashire and Yorkshire ..	109	2,090,624	72·3
Midland	285	2,366,892	65·4
Eastern Counties	177	1,044,158	50·3
Great Western	240¾	419,663	14·6

From this it appears that while the Great Western Company, on a line 241 miles long, have only carried 419,663, the Edinburgh and Glasgow Company, on a line 46 miles long, have carried 836,025; the Midland Company, 285 miles long, 2,366,892; and that while on the Great Western only 15 out of every 100 passengers conveyed are third-class, on the Eastern Counties 50 out of every 100, and on the Glasgow, Paisley, and Greenock, 83 out of every 100 are third-class passengers. Although it is true that the different character of the population and other circumstances will affect to some extent the relative number of third-class passengers on different lines, the disparity here is so great that we can come to no other conclusion than that the arrangements of such a line as the Great Western as to third-class passengers must be such as to preclude hundreds of thousands of third-class passengers yearly from using the railway who, with greater facilities, would be glad to use it. I say this with confidence, because as manager of the Glasgow and Greenock Railway, where the third-class system has been more developed than on any line in the country (and where we carried passengers at a profit for one farthing a mile), I had an opportunity of observing the real advantage and comfort which very cheap travelling is to the working class. As the results of the working of that line afforded a remarkable instance of the effects of low fares, I have thought that it might not be uninteresting to record them. The River Clyde runs beside the Glasgow, Paisley, and Greenock Railway, which is 23 miles long. The steamboats have long afforded an excellent mode of transport between Glasgow and Greenock, the fares by boat before the railway opened being from 1*s* to 2*s*., and the time occupied was about two hours. Glasgow, with a population of 274,000, was at one end of the line, Greenock, with a population of 36,000, at the other end of the line, and various summer watering places lie at the mouth of the Clyde, below Greenock. On the line were Paisley (population 60,000) and Port Glasgow (population 7,000). Between Glasgow and Paisley was a canal on which there were passenger-boats drawn by horses at a speed of 6 miles per hour. These facilities gave rise to a great traffic before the railway was opened,—the yearly number travelling along the course of the railway being 1,185,340, and the average fare 1*s*. 4*d*. Notwithstanding this, after the railway was opened (in 1843) the numbers travelling by all means of conveyance were found to exceed 2,000,000, or to have increased 100 per cent., the average fare having in the mean time fallen to 10*d*. This was the gross result; but the fares of the railway (originally 2*s*. 6*d*. first-class and 1*s*. 6*d*. second-class for 23 miles) were varied from time to time; and as I closely observed the effects of these variations, having caused an account to be taken of the number travelling by steamboat and canal as well as by railway, it may be well to state the results of these variations of fares.

First alteration.—In 1842, uncovered, open, third-class carriages, at a fare of 6*d*. for the 23 miles (or about ¼*d*. per mile), were introduced on the railway between Glasgow and Greenock, whereupon the annual number of railway passengers between those places increased 224,000, being an increase of 32 per cent. of the total number travelling (either by railway or steamboat). The number of first and second-class fell off at the same time 30 per cent., the passengers having transferred themselves from the higher class-carriages into the open third-class carriages, tempted by the difference of fares between ⅘*d*. per mile and ¼*d*. per mile. The gross receipts, however, increased simultaneously 15 per cent.; the working expenses on the other hand, did not appreciably increase, although the average number of passengers per train increased from 72 to 117.—*Second alteration*. The third-class fares were subsequently (in 1843) raised from 6*d*. to 1*s*. with the hope of increasing the revenue. The whole number travelling by railway and steamboat immediately fell off 18 per cent. The first and second class railway passengers increased by 10 per cent., but the gross receipts fell off more than 10 per cent. The effect was also tried of making the third-class carriages more comfortable by covering them in. This was found not to increase the number travelling, but it did reduce the number of first and second class passengers by 16 per cent., and therefore caused considerable loss to the company. The same experiment was repeated on the second-class carriages: they were made more comfortable by inserting glass windows instead of wooden shutters, and by carrying the interior partition higher. The number of first-class passengers shortly fell off by 12 per cent., but beyond this the second-class passengers did not appreciably increase; this experiment, therefore, also resulted in loss. The results of these experiments were then—1st. That a reduction of fares to ¼*d*. per mile even from so low a rate as ½*d*. per mile increased the number travelling by nearly a quarter of a million or by two-thirds of the whole population of the district. As these people were generally of the less affluent classes, it appears that they were actually drawn out of the noisome streets of Glasgow to the North of the Clyde by the temptation of a very low fare, and immediately that the fare was raised they were driven back again into the city. 2nd. That under the circumstances of the line in question, cheap and rapid travelling increased the number travelling; but improving the lower-priced carriages did not, however, appear to act in the same way, but merely tempted passengers from the higher class carriages—those from the second-class into the third-class carriages, and from the first to the second class:—of course it by no means follows that similar results would ensue on lines in other localities; each case must be determined by its peculiar conditions. 3rd. That no limit can be assigned to the number of travellers which cheapening and quickening the means of conveyance will create. The introduction of the railway, even where steamboats already afforded a most pleasant, rapid, and cheap communication, increased, we see, the number travelling from 110,000 to 2,000,000—2,000,000 being five times the whole population of the district. I doubt whether either at home or abroad so large a proportion of travellers to the whole population is to be found. The traffic between Glasgow and Paisley is probably the most remarkable instance on record of the increase of travelling caused by increased facilities. In 1814 there was only one coach a week between Glasgow and Paisley, conveying about 2,000 persons per annum; if we multiply this by 5 to allow for the greater number of gigs and private vehicles then in use, we only get 10,000 passengers per annum conveyed between the two places. In 1842 the numbers travelling by public conveyance between Glasgow and Paisley were upwards of 900,000. Now as the population between 1814 and 1842 had only about doubled itself, while the traffic, as we see, had multiplied itself ninety-fold, it follows that the increased facilities of transport had increased the number travelling relatively to the population 45 times: that is to say, that for every journey which an inhabitant of Glasgow or Paisley took in 1814 he took 45 journeys in 1843. These results, I conceive, place it beyond a doubt that we should spare no effort to make railway travelling cheap and within the reach of all classes.

Now, there is only one true way of encouraging cheap travelling, and that is by keeping down the original cost, and the annual expenses of railways. All the other contrivances which the public are inclined to trust, such as legislative restriction on profits, and so on, are mere quackery. Even competition is inapplicable to railways, and is not to be relied on.* Mr. R. Stephenson, the engineer, put the whole case into one sentence when he said, to "have combination is practicable—competition is impossible." The experience of all railway competition shows that this is true; when, therefore, under the plea of competition unnecessary outlay is being incurred, the public may rest assured that they will ultimately suffer for it in the charges they will have to pay.

Mr. Hill Williams, the actuary, has compiled some useful tables,† to show arithmetically "how far a remunerative charge for the conveyance of passengers and goods on railways is modified by the original cost" and other circumstances.

The following is an extract showing the effect of increased cost of construction.—

Total yearly traffic, number of passengers or tons of goods, 90,000.

	Original cost of Construction £15,000 per mile.	Original cost of Construction £20,000 per mile.	Original cost of Construction £25,000 per mile.	Original cost of Construction £30,000 per mile.
Fixed charge per mile on every passenger or ton of goods requisite in order to give common interest, 5 p. cent. on the outlay	d. 1·00	d. 1·33	d. 1·66	d. 2·00

We see from this that the fixed charge on every ton of goods or passenger must average 2*d*. per mile to return common interest on a railway costing 30,000*l*., whereas if the railway cost 20,000*l*. 1⅓*d*. per mile would be sufficient, and if it cost 15,000*l*. 1*d*. per mile would be sufficient.

After a series of similar observations, the author concludes as follows:—The result of the preceding inquiry is, it appears to me, on the whole satisfactory. The railway system has doubled itself in the last three years. Fares have been greatly reduced. Third-class passengers have largely increased. The importance and value of the traffic in goods and cattle relatively to the passenger traffic have become more apparent. The number of trains is greater and the speed of some of the trains has been accelerated; and all this has been effected without any falling off in the average receipts on each mile of railway in working, but with an increase probably sufficient to meet the increase of the working expenses attendant on the increased accommodation now afforded by railways: whatever falling off in dividends there may have been, is, therefore, to be attributed in a general view of the subject to the capitalization of loans and the creation of fictitious capital by the purchase of railways at premiums, and, therefore, at sums beyond what they actually cost. These being profitable speculations when shares were high, were pushed to such an extent as now to press severely on the original share capital of railway companies. The great evil of the last three years is the extravagant outlay of money which has taken place; an outlay which, instead of being checked by the legislature, has been encouraged to the utmost by the mode of inquiry adopted. This has inflicted on the railway system a burden which it will never be able to throw off, and which the public will always have to bear with them in a higher rate of charge for conveyance than would with common prudence have been necessary. It only remains to stop the extravagance with a strong hand. The very existence of the railway companies depends on the economy they can practise in making and working their railways; and nothing which on the face of it involves increased outlay, be it diversity of gauge and its consequence the mixed gauge, or the more plausible plea of competition, should be countenanced either by railway companies or by the legislature, if we wish to secure for ourselves the full fruits of that admirable invention which England and English engineers who have followed in the steps of George Stephenson have given to the world.

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* Evidence Select Committee on Railway Act Enactments, 1846.

† Appendix No. 7, Select Committee on Railway Act Enactments, 1846.

ANEMOMETRY.

"*Report of further progress of Anemometrical Researches.*" By Professor PHILLIPS.

Referring to the report on this subject presented to the Southampton Meeting, the author recapitulated the steps of the investigation by which he had been conducted to propose the evaporation of water as a measure of the velocity of air-movement. In the former researches, the conclusion which may be drawn *à priori* from Dr. Apjohn's formula for the relation of the temperature of the dew point to that of an evaporating surface was verified; and the *rate of cooling* of a wet bulb in the open air was found to be *cæt. par.* simply proportional to $t - t'$ (t being the temperature of the air, t' that of an evaporating surface). The air-movement was found to affect the rate of cooling nearly in proportion to the square root of the velocity; and thus by simply observing the rate of cooling of a wet bulb exposed to a current of air, and also the value of $t - t'$, the velocity of the air current becomes easily calculable. But this instrument is only an *anemoscope*, of extreme delicacy and various applicability indeed, but incapable of being converted to a self-registering *anemometer*.—It appeared to the author probable that the *rate of evaporation* followed nearly or exactly the same law as the rate of cooling,—the same reasoning in fact applying to each case. This was tested by experiment in a great variety of ways, with instruments of extremely various forms, and with velocities of air-movement from 400 yards to 27,000 yards in the hour. The velocities of the wind were measured by a very lightly-poised machine anemometer of Dr. Robinson's construction, but without any wheel-work, the revolutions being counted by the observer.—In the course of these experiments some apparently anomalous circumstances in the rate of evaporation occurred to the author; but these he hopes to be able to interpret by further careful research, and finally to present in the compass of a few cubic inches an anemometer specially suited to measure and record the low velocities of wind, and furnish a useful complement to the larger machines already esteemed to be so important in meteorology.

HEIGHT OF WAVES.

"*On the Velocity and Height of Waves,*" as observed by Capt. STANLEY; being the result of experiments made on board H.M.S. *Rattlesnake.*

The method adopted for the determination of the length and speed of the sea was to veer a spar astern by the marked lead line, when the ship was going dead before the wind and sea, until the spar was on the crest of one wave, while the ship's stern was on the crest of the preceding one. After a few trials, it was found that when the sea was at all regular, this distance could be obtained within two or three fathoms, when the length of wave was 50. In order to ascertain the speed of the sea, the time was noted when the crest of the advancing wave passed the spar astern, and also the time when it reached the ship; and by taking a number of observations, there is every reason to believe results have been obtained not very far from the truth. The officer noting the time in all these observations having only to register the indications of the watch when the observer called "Stop," had no bias to induce him to make the differences more regular. For measuring the height of the waves, a plan recommended by Mrs. Somerville was adopted—which Capt. Stanley has tried for ten years with great success. When the ship is in the trough of the sea, the person observing ascends the rigging until he can just see the crest of the coming wave on with the horizon, and the height of his eye above the ship's water-line will give a very fair measure of the difference of level between the crest and hollow of a sea. Of course, in all these observations, the mean of a great many have been taken; for even when the sea is most regular, apparently there is a change in the height of the individual waves. In order to show how closely the different results came, observations on different days are given from which they were deduced,—

Experiment, No. 1.

Length of sea, 55 fathoms; speed of ship, 7·2 knots; height of wave, 22 feet; time the wave took in passing from spar to stern, 10 seconds; speed of sea deduced, 27′ per hour.

Experiment, No. 2.

Times observed of wave
passing from spar to stern.
Sec.
8·7
7·0
9·2
6·3
7·0
8 6
8·8
8·4
8/64·0
8·0 Mean time of wave going from spar to stern.

Length of wave, 43 fathoms.
Average height, 20 feet.
Speed of ship, 6 knots.
Speed of wave deduced, 24·5 nautical miles per hour.

Experiment, No. 3.

Sec.
7·4
13·0
10·7
10·0
10·2
9·0
6/60·3
10·0 Mean time of wave passing from spar to stern.

Length of wave, 50 fathoms.
Height of wave, 20 feet.
Speed of ship, 6 knots.
Speed of wave deduced, 24 nautical miles per hour.

Experiment, No. 4.

Sec.
7·5
7·0
10·0
9·0
9·0
10·0
9·0
8·0
9·5
9/79·0
7·8 Mean time of wave passing from spar to stern.

Length of wave, 30 to 60 fathoms.
Height of wave,—
Speed of ship, 5 knots.
Speed of wave deduced, 22·1 nautical miles per hour

Experiment, No. 5.

Length of wave, 33 fathoms.
Speed of ship, 6 knots.
Speed of wave deduced, 22·1 nautical miles per hour.

Experiment, No. 6.

Sec.
12·0
9·0
7·5
10·5
10·5
13·0
6/62·5
10·4 Mean time of wave going from spar to stern.

Length of wave, 57 fathoms.
Height of wave, 22 feet.
Speed of ship, 7 knots.
} Sea irregular; observations not very good.
Speed of wave deduced, 26·2 nautical miles per hour.

Experiment, No. 7.

Sec.
9·5
6·5
8·0
8·5
7·0
12·5
10·0
7/62·0
8·9 Mean time of sea passing from spar to stern.

Length of wave, 35 fathoms.
Height of wave, 17 feet.
Speed of ship, 7·8 knots.
Speed of wave deduced, 22 nautical miles per hour.

Summary of Observations.

Date. 1847.	Number of Observations.	Force of Wind.	Speed of Ship.	Height of Wave.	Length of Wave.	Time of Wave passing from spar to stern.	Speed of Sea deduced.	Remarks.
April			Knots	Feet.	Fms.	Seconds	Knots	
21		5	7·2	22	55	10·0	27.	Ship before the Wind, with a heavy following Sea.
23	8	5	6·0	20	43	8·0	24·5	Ditto.
24	6	4	6·0	20	50	10·0	24·0	Ditto.
25	9	4	5·0		35 to 40	7·8	22·1	Sea irregular.
26		4	6·0		33	7·4	22·1	Heavy following Sea.
May								
2	6	(4·5)	7·0	22	57	10·4	26·2	Sea irregular—observations not very good in consequence.
3	7	5	7·8	17	35	8·9	22·	Wind and Sea a little on port quarter.

Note.—The numbers denoting the strength of the wind are those used by Admiral Beaufort.

Atmospheric Waves.

"*Report on Atmospheric Waves.*" By Mr. Birt.

The report consists of three parts:—The first denoting the information we now possess relative to such waves as have been determined: the second treating of the barometric curves which result from the crossing of the north-westerly and south-westerly waves, the two principal systems common to Europe—the most prominent subject being that particular curve known as the "great symmetrical wave of November:" and the third embodying the results that have been obtained during the last year illustrative of the symmetry of the "great wave," more particularly the locality of greatest symmetry and the departure from symmetry in certain directions. Under the second head, the author has thrown together the result of his inquiries into the *forms* presented by the barometric curves at certain stations, and has devoted attention to the symmetrical curve of November as it has been observed at the Observatory at Greenwich in the years 1841 to 1845. In connection with this subject, the author remarked "it has been assumed that the symmetrical wave of November consists of *five* subordinate waves giving rise to the five maxima which characterise it, the central maximum forming the apex of the symmetrical curve, the remainder being subordinate thereto. ("Association Reports," 1846, p. 125.) Upon a close inspection of the curves of the "great wave" as laid down from the Greenwich observations, six subordinate maxima can be traced, three on each side the central apex, which in all the years is by far the most prominent. The mean curve leads to the conclusion that *Greenwich is not the point of greatest symmetry,* its closing portion being depressed more than two inches below the commencement. The next feature is the decided rise of the mercurial column during a period of sixty-eight hours preceding the transit of the crest: the value of this rise is ·7 inch or about ·010 inch per hour. The fall is not so precipitous; the barometer appears to be *kept up* in this locality by the *first subordinate maximum* succeeding the crest, so that at the epoch of sixty-eight hours after transit the value of the reading is more than 2 inches higher than at sixty-eight hours before transit. At eighty hours after transit a precipitous fall commences, which continues during the next twenty-four hours, the mercury sinking ·36 inch or about ·015 per hour. The fall afterwards continues with two slight interruptions, answering to the subordinate maxima, until the close of the wave 148 hours after transit." The peculiar features of the mean curve, especially the difference between the initial and terminal readings, ·241 inch, combined with certain features exhibited by the "great wave" at its last return, has suggested the possibility of expressing numerically the departure from symmetry for any station that may be selected. This departure from symmetry is strikingly manifested by the observations of 1846, especially as we proceed from Brussels, the European nodal point, towards Ireland and the north-west of Scotland, and is well seen in the series of curves illustrating the author's report in the last volume of the "Association Reports." Three principal maxima, characterise these curves on the 5th, the 9th, and the 12th of November; and the differences of altitude between those of the 5th and 12th have been employed to indicate the deviation from symmetry in the direction already alluded to. The discussion of these differences and the results deduced from them form the third part of the report. The author has laid down on a map of the British Isles these differences, and from them constructed a chart of the lines of equal deviation from symmetry: these lines range from ·100 inch—which passes north-west of the Channel Islands, proceeds towards the Isle of Wight, skirts the shores of Sussex and Kent, and passes through Ramsgate—to ·550 inch, which passes through Limerick, is slightly curved as it crosses Ireland, and proceeds nearly in a straight line across the Scottish Islands to the north-west of Great Britain. The values of these lines express the *depression* of the maximum of the 5th below that of the 12th. Among these lines the author regards the direction of that representing ·260 inch as the best determined. It appears to have passed near and to the west of Helstone, this station exhibiting a deviation of ·258 inch; it then proceeded along the coast of Cornwall and Devonshire, crossed the Bristol Channel, entered Wales, and continued its course across Glamorganshire towards Brecon, which it left to the north-west as it rather abruptly changed its direction and proceeded towards Gloucester, which it passed through. It appears to have undergone considerable inflection as it traversed the central parts of England, rising again towards Nottingham, which is removed ·025 inch from it to the west: it finally left the shores of England at the south-eastern angle of Yorkshire and entered on the German Ocean. The author solicited attention to a feature which characterises all these lines, especially the one just traced, viz., the decided inflection they undergo as they pass over the land. The chart exhibits *two* systems of inflection, one being peculiar to Ireland and England; the general direction of the lines undergoing a change as the line of greatest symmetry is approached, the inflection being governed apparently by the masses of land: and the other to Scotland, the inflection being very decided over the land northward of the Frith of Forth. From the *single* instance discussed by the author, the result appears to be that the symmetry of the barometric curve is departed from in a greater degree at *inland* stations, a greater difference between the points selected being exhibited at such stations than at the sea coast on either side. The report closed with some remarks on the non-persistency of the *direction* of these lines of deviation from symmetry, and on the high probability that they revolve about the nodal point of the two principal systems of atmospheric waves, Brussels.

Health of Towns.

"*Report on the Air and Water of Towns.*" By Dr. Smith.

In commencing his report the author says, it has long been believed that the air and the water have the most important influence on our own health,—and superstitions have therefore constantly attached themselves to receptacles of the one and emanations of the other. The town has always been found to differ from the country: this general feeling is a more decisive experiment than any that can be made in a laboratory. The author proceeds to examine all the sources from which the air or the water can be contaminated. The various manufactures of large towns, the necessary conditions to which the inhabitants are subjected, and the deteriorating influences of man himself are explained. If air be passed through water a certain amount of the organic matter poured off from the lungs is to be detected in it. By continuing this experiment for three months, Dr. Smith detected sulphuric acid, chlorine, and a substance resembling impure albumen. These substances are constantly being condensed upon cold bodies, and in a warm atmosphere the albuminous matter very soon putrifies and emits disagreeable odours. The change which this substance undergoes by oxidation, &c., is next examined,—and shown to give rise to carbonic acid, ammonia, sulphuretted hydrogen, and probably other gases.

The ammonia, generated fortunately from the same sources as the sulphuretted hydrogen, materially modifies its influences. The consequences of the varying pressure of the atmosphere have been observed; and it is shown that the exhalations of sewers, &c., are poured out in abundance from every outlet when the barometric pressure is lowered. By collecting the moisture of a crowded room by means of cold glasses and also dew in the open air, it was found that one was thick, oily, and smelling of perspiration, capable of decomposition and production of animalcules and confervæ,—but the dew beautifully clear and limpid. Large quantities of rain-water have frequently been collected and examined by Dr. Smith; and he says,—I am now satisfied that dust really comes down with the purest rain, and that it is simply coal ashes. No doubt this accounts for the quantity of sulphites and chlorides in the rain, and for the soot, which are the chief ingredients. The rain is also often alkaline,—arising probably from the ammonia of the burnt coal, which is no doubt a valuable agent for neutralising the sulphuric acid so often found. The rain-water of Manchester is about 2¼° of hardness,—harder, in fact, than the water from the neighbouring hills which the town intends to use. This can only arise from the ingredients obtained in the town atmosphere. But the most curious point is the fact that organic matter is never absent, although the rain be continued for whole days. The state of the air is closely connected with that of the water: what the air contains the water may absorb—what the water has dissolved or absorbed, it may give out to the air.

The enormous quantity of impure matter filtering from all parts of a large town into its many natural and artificial outlets, does at first view present us with a terrible picture of our underground sources of water. But when we examine the soil of a town we do not find the state of matters to present that exaggerated character which we might suppose. The sand at the Chelsea Waterworks contains only 1·43 per cent. of organic matter after being used for weeks. In 1827 Liebig found nitrates in twelve wells in Giessen, but none in wells two or three hundred yards from the town. Dr. Smith has examined thirty wells in Manchester, and he finds nitrates in them all. Many contained a suprising quantity and were very nauseous. The examination of various wells in the metropolis showed the constant formation of nitric acid; and in many wells an enormous quantity was detected. It was discovered that all organic matter, in filtrating through the soil, was very rapidly oxidized. The presence of the nitrates in the London water prevents the formation of any vegetable matter,—no vegetation can be detected, even by a microscope, after a long period. The Thames water has been examined from near its source to the metropolis, and an increasing amount of impurity detected.

In the summary to this report, Dr. Smith states that the pollution of air in crowded rooms is really owing to organic matter and not merely carbonic acid,—that all the water of great towns contains organic matter,—that water purifies itself from organic matter in various ways, but particularly by converting it into nitrates,—that water can never stand long with advantage unless on a large scale, and should be used when collected or as soon as filtered.

Steam Navigation.

"*On the Improvements which have been made in Steam Navigation.*" By Mr. Scott Russell.

The first great improvement that had been made was in the boilers. Formerly, the boiler-flues were constructed of great length, so that the smoke was kept winding round and round in the flues and at last was allowed to escape with difficulty. Now, however, they had adopted the plan of getting as much fire as possible in the shortest space of time,—and this had been accomplished by imitating as nearly as they could the locomotive engine boiler, by having tubes of thin metal which would evaporate a much greater quantity of water in the same time as flues of the usual thickness; now, also, instead of taking the smoke a long dance as in the old fashion, they used short flues of four to six feet in length, and by having a great many of as thin metal as possible they heated the greatest quantity of water, and had the additional advantage of keeping the metal cool,—in consequence of which a boiler of smaller extent and surface was of much greater efficiency with less weight of metal. The next point of improvement was in the engine; in the construction of which, however, there had been less change than in other matters. The former beam-engine had been changed for the direct-action engine, which was of various kinds; but the greatest change which had been made within the last ten years consisted in the employment of greater quantities of wrought-iron in the construction of the engines, instead of the mass of cast-iron formerly used. This was the only great change,—for the newest Halifax steamers were still fitted up with the old-fashioned or lever-engines. The next improvement consisted in working steam expansively to a much greater extent than heretofore. It was only within the last ten years that they had adopted this principle: the effect of which was that instead of completely filling the cylinder with steam, they filled only to the extent of one-fourth —a volume of steam not of course of equal density, but by which they got two-thirds of the work done and at one-fourth of the cost. The next improvement had been made in the paddle; not so much, perhaps, in the wheel itself—for he was still inclined in favour of the old paddle-wheel, although for short voyages he admitted the advantage of the feathering paddle-wheel which had been advocated by Mr. Price at their Meeting some years ago, and he had then opposed him:—but of this by-and-by. Another great improvement which had been made was the driving the paddle-wheels faster. They had an old maxim which was, whereas a good old horse going 2½ miles an hour could not draw advantageously at more than 220 feet per minute, and that as the steam-engine was only a substitute for horses, and reckoned as so much horse-power, it ought not to go faster than 2½ miles per hour—and this one thing had kept them back for half a century. He did not mean that the result should not be faster than 2½ miles per hour, but that the piston should not rise up and down in the cylinder faster than 2½ miles an hour, which was only four feet in a second, while the motion of steam of 15 lb. was 1,100 feet in a second. Fortunately, however, this old maxim had been abandoned, and the piston now moved from 250 or 270 to 300 feet in a minute. For this improvement they were indebted to no new principle, but to the application of mathematical principles of science. He now came to another great improvement, which was the change in the formation of steamboats, which had been radical—he meant the entire alteration of the form of the ships. A few years ago steam-vessels which would go ten or twelve miles an hour were deemed fast ships; now, however, we had attained a much higher rate of speed. Vessels were then built on the old-fashioned principle that the water-line should be nearly straight, and that the run of the vessel should be a fine line, and that there should never be a hollow line, except a little in the run of the ship, but that there most certainly should not be any hollow line in the bow, for there the water-line should be straight or a little convex. Researches and inquiries were, however, made by a Committee of the British Association as to the form which would enable the vessel to go fastest through the water. These inquiries lasted for years, and they established, by a series of experiments, a set of very curious facts. Formerly, every builder of ships had his notion of proportion; some that the length should be four times the breadth—others that it should be 4½ or 5, —and some went as far as to say that the length should be six times the breadth, but these were deemed innovations; so that although the proportions of width as compared with breadth were said to be fixed ones, yet strangely enough every one differed as to those proportions. Another question was what part of the vessel should have the greatest width, and it was generally thought that the greatest width should be nearest the bow. Some daring persons had, however, put it back as far as the centre of the ship. This was, however, the exception, and not the rule. Then there was another great principle, which was that the bow and stern should exactly balance each other,—that is, that the vessel should be equally balanced; but the new rules which the British Association had established were as follows:—They began by upsetting the old rule with respect to the proportions which the length should bear to the breadth, finding that the greater the speed required the greater should be the length, and that the vessel should be built merely of the breadth necessary to enable the engines to be put in, and to stow the requisite cargo. Then the second great improvement made by them was that the greatest width of water-line, instead of being before the middle, should be abaft the middle of the vessel, and in fact two-fifths from the stern, and three-fifths from the bow. The next great improvement was that, instead of having the bow broad and bluff, or a cod's-head bow, for the purpose of rising over the wave, you might have hollow water-lines, or what were called wave lines from their particular form, and with that form the vessel would be propelled with less power and greater velocity,—and also that instead of keeping to the old fine run abaft and cutting it away you might with great advantage have a fuller line abaft, provided it was fine under the water. Thus by these improvements the form of the old vessel was pretty nearly reversed, to the great annoyance of the old school, and the steamers were given large and commodious cabins and after-holds, instead of having cabins so pinched in that you could hardly stand in them. Another heresy introduced by the British Association was, that of the principle as to the balance of the stern and the bow upon which they now rested; but which was founded in a most singular error, for they left out something which was very material. They concluded that the wave acted equally on both ends of the vessel in striking it; but they did not take into consideration the impossibility of this when a vessel was moving, not having taken into calculation the velocity of the wave or of the vessel, and that from this circumstance the concussion from a wave striking the bow would be a most powerful one, while it could not be so with regard to the stern, because if the velocity of the wave meeting it was fifteen miles, the shock would be as of thirty miles; and, therefore, it became most plain that the bow would give the greatest resistance to the wave. He had examined all the fastest steamers which had accomplished from fifteen to seventeen miles an hour—and in smooth water eighteen miles an hour; and he would venture to state that there was not one of them which accomplished fifteen to seventeen miles an hour, which had not all these alterations in every particular, and that the wave form and wave principle were now adopted by all the great steam-ship builders, and that all the fast steamboats had what was called the wave-bow. Now, of the eight boats on the Holyhead and Dublin stations, if examined, it would be found that all of them were built on these principles, although in some of them there was still left a little of the old principle, some of the boats being made a little fuller and more straight; and if any one would look at one of these boats, it would be perceived that the moment they moved the very wave itself rebelled against them and broke against their bows,—and that consequently these were slower than any of the class; and he gave the details of their construction,—for which we have not space. All of them were examples of the value of the form and the principles which the British Association had advocated and introduced at a very early period in its history.

Mr. J. Taylor stated, that as Treasurer of the Association, he could bear witness to the value of the efforts of the Association in this direction; and he felt bound in justice to state that the credit Mr. Russell had given to the Association was chiefly due to himself, as the individual who, with the late Sir J. Robinson, had conducted the investigations on this subject.

"*On Common Salt as a Poison to Plants.*" By W. B. Randall.

The following notice is presented as being likely to afford a useful practical caution to those interested in the cultivation of plants. In the month of September last, three or four small plants in pots were shown to the writer, nearly or quite dead; and he was, at the same time, informed that their destruction was a complete mystery to the party to whom they belonged, and that Dr. Lindley had expressed his opinion, from the examination of a portion of one sent to him, that they were poisoned. Having searched in vain for any strong poison in the soil, and in the plants themselves, he inquired more minutely into the circumstances of the case, and found that these were only specimens of many hundreds of plants both in the open air and in green-houses (but all in pots) which exhibited, in a greater or less degree, the same characteristics. The roots were completely rotten, so as to be easily crumbled between the fingers; the stems, even in young plants, assumed the appearance of old wood; the leaves became brown, first at the point, then round the edge, and afterwards all over; while the whole plant drooped and died. At least, 2,000 cuttings in various stages of progress, and 1,000 strong, healthy plants had been reduced to this condition; including different varieties of the fir, cedar, geranium, fuchsia, rose, jasmine, and heath. The sight of this wholesale destruction, coupled with the fact that the whole were daily watered from one particular source, suggested the conclusion that the cause of the evil must reside in the water thus used; and this was accordingly examined. It yielded the following constituents, making in each imperial pint of 20 fluid ounces, nearly 9½ grains of solid matter entirely saline, without any organic admixture:—

Carbonate of lime	0·600
Sulphate of lime	0·462
Chloride of calcium	0·200
Chloride of magnesium	1·252
Chloride of sodium	6·906
	9·420

The mould around the plants and an effusion of the dead stems and leaves also afforded abundant evidence of the presence of much chloride of sodium. Further inquiry showed that the well from which the water was procured had an accidental communication, by means of a drain, with the sea; and had thus become mixed with the salt water from that source, and had been used in this state, for some weeks, probably from two to three months. From about that time the plants had been observed to droop; but it was not until nearly the whole of a valuable stock had been destroyed, that any extraordinary cause of the evil was suspected. To place it beyond doubt that the water was really the cause of the mischief, twelve healthy fuchsias were procured from a distance and divided into two parts; half being watered morning and evening with the water in question, and the others with rain water. In a week, the six plants watered from the well had turned brown, and ultimately died, while all the rest remained perfectly flourishing. Assuming from these facts, that the common salt in this water was the chief cause of the results described, it is proved that water containing about seven grains of salt in each pint is, in its continued use, an effectual poison to the weaker forms of vegetation; or that when a soil is continually watered with a weak solution of salt it gradually accumulates in it until the soil becomes sufficiently contaminated to be unfit to support vegetable life. In either case an interesting subject of inquiry is suggested—What is the weakest solution of salt which can produce in any measure this poisonous effect?—or, in other words, at what degree of dilution does the danger cease? For salt is an important natural constituent of much spring water, quite independent of any infiltration from the sea, as in this instance. Thus:—the water of the artesian well, Trafalgar-square, London. contains in each gallon about 20 grains; that at Combe and Delafield's Brewery, 12·7; that at Wolverhampton Railway Station 6; one lately sunk at Southampton, for supplying a private manufactory, 40. May it not be asked, whether the subject of the suitableness of waters in general for the various purposes to which they are applied—be it in manufactories or for steam-engines, domestic purposes or drinking—is not worthy of a greater share of scientific attention than it has hitherto commanded?

Geology of South Wales.

On the Geology of Portions of South Wales, Gloucestershire, and Somersetshire. By Sir H. T. De la Beche.

The rocks of this district have originated in several distinct ways: some have had a mechanical origin, and consist of the detritus of older rocks broken into fragments or reduced to powder, and brought down from the land by rivers, or worn by the breakers from the coast; others have been deposited from a state of chemical solution, like some of the limestones; and some have been formed almost entirely from the aggregation of organic remains. The materials obtained from the destruction of the older rocks have been employed over and over again in the formation of those of later date.

1. The most ancient strata of the district have been denominated Cambrian and Silurian: the former may be seen in Pembrokeshire, towards St. David's. They contain the earliest fossil remains which have been discovered. Numerous volcanoes appear to have been active at this period, ejecting quantities of ashes which, falling into the sea, entombed the animals living on its bed. Even at this early period there may be discovered indications of portions of the sea's bed having been upheaved so as to form dry land or islands. Subsequently a depression took place, and an accumulation of sand was spread over the whole, constituting what is called the Caradoc sandstone. After many thousands of feet of materials had thus been accumulated and become consolidated, another contortion and folding of the strata took place, followed by a change in the nature of the materials deposited in the sea.

2. The second series of deposits constitute the Old Red Sandstone, which consists mostly of detrital matter, but contains occasional beds of impure limestone (*cornstone*), and in its lower part there is a great thickness of marl, also coloured red by per-oxide of iron, and occasionally streaked with blue and green where the iron has been reduced to a lower state of oxidation by the presence of decomposing vegetable matter. The upper beds consist of coarse sand and gravel cemented together and forming a hard conglomerate; the multitude of quartz pebbles, derived from *veins*, indicates an immense destruction of older rocks. No fossils are found in this formation, because sands are always barren, and per-oxide of iron is fatal to animal life when it exists in excess; but in the *cornstones* a few remarkable fishes (*Cephalaspis, &c.*) have been obtained. These rocks appear to have been formed near a coast, whilst at a small distance in Cornwall and Devon the sea was depositing fine sediment, was free from the injurious per-oxide, and abounded in organic life. The Old Red Sandstone is sometimes conformable to the underlying Silurian rocks,—at others unconformable; and in the Valley of the Towy it begins to overlap the Upper Silurian and rest upon the Lower Silurian rocks; further west, it is itself overlapped by the coal-measures which there rest on the Silurians.

3. After this another great change took place, and the sea deposited carbonate of lime, forming the carboniferous limestone, well shown on the coast of Pembrokeshire. The lower part of this series consists of sandstones and shale, in which the remains of fishes occur in abundance. Mollusca also appear; and soon the abundance of organic remains becomes so great that whole strata are formed of their remains: indeed, the carbonate of lime seems to have been chiefly produced by the agency of animal life. This limestone, which is sometimes 2,000 feet thick, dwindles to 70 or 80 feet towards Haverfordwest, and does not appear to have extended far to the north. Here a change of mineral character takes place in the coal-measures, originally consisting of mud, sand, gravel, and accumulations of vegetable matter. The lowest division, millstone grit or farewell rock, is usually a white quartzose sand, but sometimes a calcareous mudstone with organic remains, the equivalent of the culm of Devon. Above this were formed beds of mud and sand, with occasional beds of vegetable matter and carbonate of iron; these beds diminish in thickness from Merthyr Tydvil to Pont-y-pool; and are wanting in Dean Forest, but exist in the Bristol field. With respect to the origin of the coal in this district, there is evidence that it originated in accumulations of vegetable matter which *grew on the spot*. The conditions under which the beds of coal occur have been described minutely by Mr. Logan; under each coal seam is a bed of sandy clay, full of the fossil plants known as *Stigmariæ*, and which Mr. Binney has shown to be the roots of another plant, the *Sigillaria*, equally abundant in the coal, which must have grown in swamps near the sea. After each great accumulation of vegetable matter, the land seems to have subsided, and the sea flowed in, bringing sand and mud and marine shells; again marshes were formed and fresh accumulation of peat and plants, to be in turn covered by silt from the sea. Evidence of the local origin of the coal is also afforded by the frequent occurrence of fossil trees with their trunks erect and their roots spreading out in the clay below; several of these trees, each 14 or 15 feet high, were discovered at the head of the Taw Valley; the outside of their trunks appears to have been originally hard and to have resisted the action of water for some time, but their interior was soft and soon became hollow and filled with mud, which is regularly stratified; the sandstone on the outside of the trees also bears traces of the rippling of the water around them. The iron ore of the district occurs in the form of nodules of argillaceous ironstone, lying in courses; the cracks in these nodules being filled with carbonate of iron just as those in the cement-stones (*septaria*) of the lias are filled with carbonate of lime. One of the phenomena of the coal district is the occurrence of cracks, attended with the displacement of the beds on either side; these *faults* are numerous, and amount in one instance to 2,400 feet; the cracks are sometimes wide, whilst at others the sides are in close contact. Many of the faults appear to have been formed before the deposit of the magnesian conglomerate; but others appear to have been formed at almost every subsequent period. In some instances beds of coal seem to have been partially washed away before the accumulation of the succeeding bed, giving rise to spurious faults, such as that called the "Horse" in the Forest of Dean.

4. At the conclusion of the coal period, all the existing rocks appear to have been squeezed and contorted not only in Britain, but over a great part of Europe, a new deposit of detrital matter began to be formed, similar to those before the coal period, and called by way of distinction the *New* Red Sandstone. Where this formation approaches the older rocks it puts on the appearance of a shingle bed, in which the detritus of the older rocks is cemented together by carbonate of lime and magnesia, hence termed the magnesian conglomerate. These fossil beaches are thickest on the south-west and west flanks of the Mendip and other hills, indicating an open ocean and prevalent winds in that directron. In the red sandstone and marls formed at the same time, but further from the coast, there are no traces of animal life; but as the red stain disappears from the rocks, towards the conclusion of the period, remains of fishes and shells appear.

5. Further subsidences took place; the sea, now freed from the per-oxide of iron, swarmed with animals of extraordinary form and structure. We still trace its boundaries in Glamorganshire and the Mendips by beds of rolled pebbles from the subjacent rocks, and close to these sheltering coasts the remains of marine saurians abound in the consolidated mud and limestone (*Lias*), along with the bones of the flying *Pterodactyle*. Somewhat later, great beds of oolitic limestone were accumulated in the sea, which now constitute the Cotteswold Hills and their extension to Bath and Dorsetshire.

6. No further history is afforded by this district until comparatively moern times, when we find evidence of subsidence beneath the sea and of agencies by which the present form of the surface was accomplished. The present land must have been at least 1,500 feet lower; and, therefore, nearly all under the sea. There is also evidence that the climate became cold, that there were glaciers in the mountains of North Wales and icebergs floating round the shores, carrying blocks of stone and gravel and presenting all the phenomena of polar regions. The sea also accumulated beds of clay, in which the few existing shells are of Arctic character. Still later, the land must have risen again above the sea to an elevation greater than it now has, for we find *submarine forests* fringing all the shores of Europe from Spain to Norway. Of this, one of the best examples occurs in Swansea Bay, where the stumps of oak and alder may be seen at low water, 20 or 30 feet lower than they could have grown.

"*On the Relative Position of the various Qualities of Coal in the South Wales Coal-field.*" By S. Benson, Esq.

The coal is of three kinds: 1. bituminous, the small of which will coke; 2. free-burning, the small of which will not coke, but which burns with great rapidity and a considerable volume of flame; 3. anthracite or stone coal. These three pass into one another imperceptibly; the same vein of coal changing gradually from bituminous to free-burning, and from this to anthracite.

1. The coal beds which crop out on the south side of the basin are highly bituminous, becoming less so towards the north. The five-foot vein, extensively worked near Swansea on the south rise, is highly bituminous,—on the north rise, within a distance of two miles, it becomes free-burning. The various beds also differ considerably in their bituminous qualities and commercial value.

2. The free-burning coals occupy a tract running north-east and south-west through the centre of the coal-field. Those which are intermediate between the free-burning and bituminous are perhaps better adapted than any for smelting purposes,—and in the neighbourhood of Merthyr form the chief supply for the blast furnace, being either used raw or the large only being coked in the open air. The pure free-burning coals are less adapted for smelting, but are preferred for steamers from their readiness of combustion and the absence of clinkers in the grate. Free-burning coals are admitted to government contracts from the following places: Llangennech, Camerons, Graigola, Brindowey, Resolven, and Aberdare.

3. The northern side of the basin is occupied by the anthracite, which graduates through the various "culms" into the free-burning coal. In Pembrokeshire the coal is all anthracite. Taking the area of the Glamorganshire coal-field at 750 square miles, it is estimated that $\frac{11}{12}$ths of this area is occupied by bituminous and free-burning coals, and the remainder by culm and anthracite. It appears that the beds of coal on the south crop lose their bituminous qualities gradually as they dip to the north; so that if on a section lines are drawn to show the boundaries of the qualities of coal

they will not be vertical but inclined to the north. If the change in the quality of the coal is attributed to the influence of subterranean heat, then the inclination of these lines will serve to point out the direction from which that heat acted, namely, from the north-west of the coal-field.

Mr. **Booker**, being called on by the President for some statistical information, stated that there were 159 blast furnaces in the district employed in smelting iron, and that 550,000 tons of iron were annually manufactured. The coal raised in the district was employed as follows :—

1,500,000	tons annually in the manufacture of iron.
200,000	„ „ „ „ copper.
150,000	„ „ „ „ tin.
750,000	„ employed in domestic purposes and in agriculture.
1,750,000	„ exported.
4,350,000	tons per annum.

At this rate, and supposing the coal to exist only over 100 square miles, there was sufficient for 1,400 years to come. The value of the exports from the district, consisting of iron, &c., in a state of rough manufacture, amounted to 4,000,000*l.* a year.

"*On the Submergence of Ancient Land in Wales; the Accumulation of newer Strata around and above it; and the Re-appearance of the same Land by Elevation and Denudation.*" By Professor A. C. **Ramsay**.

This communication was illustrated by a section, on a true scale, of the rocks near Builth, in Radnorshire, where the Wenlock shales rest unconformably on the Llandeilo flags. The lower rocks must have been elevated previously to the formation of the upper, and their upturned edges must have been worn away by the sea when the upper rocks were deposited or previously. No power is known to exist far below the level of the sea, by which this process could have been effected; it must have taken place at the sea's level. Throughout Wales the Lower Silurian rocks appear to have been disturbed at one particular period, to have been heaved above water and formed a coast, around which the succeeding rocks were accumulated. Near Bishop's Castle the upheaval of the Llandeilo flags was followed by the deposition of the Caradoc sandstone, which is full of pebbles of the older rocks. After this a subsidence appears to have taken place, the area of the sea was increased, and the Wenlock shale was deposited not only over the Caradoc sandstone, but beyond it, as at Builth, upon the Llandeilo flags; and in some places the shale rests on greenstone rocks and certain pebbles from it, being in fact a gravelly sea bottom. This depression of the bed of the sea continued also during the deposition of the Ludlow rocks, which are conformable to the Wenlock shale; and there is no marked alteration in the organic remains of the two rocks. The Wenlock shale is 1,500 feet thick, and the Ludlow rocks 3,500 feet; and as it is certain that their organic remains could not have existed at the depth of 5,000 feet, we must suppose a gradual subsidence of the area, such as is believed to be now taking place amongst some of the coral islands, until 5,000 feet of rocks was accumulated over what had been dry land. The old red sandstone, which has a maximum thickness of 8,000 feet, appears also to have extended over this country, judging by the outliers, at a considerable distance to the north and west. Subsequently, the whole of this series, from the Caradoc sandstone upwards, was removed, and the ancient Silurian strata became the surface of dry land as they had been so long before. It now became a question, what amount of alteration may the Silurian rocks have undergone during the time they were so covered up? If the same laws regulated the ascent of the internal temperature as at present, namely, 1° for every 54 feet, then the addition of 5,000 feet of rock would have raised the temperature by 92°, whilst 9,000 feet would have added 160°, and with 11,000 of superincumbent strata the Lower Silurian rocks must have endured an increased temperature of 212°. To influences of this kind may, perhaps, be attributed the crystalline or metamorphic condition of some of the more ancient rocks,—as suggested by Sir J. Herschel, in a paper communicated years ago to the Geological Society of London.

The **Dean of Westminster** referred to the Portland rock, in which a bed of vegetable soil occurs, full of trunks of trees, and cycadites; this bed rests on limestone containing ammonites, and is covered by similar marine deposits. Again in the Weald, fossil forests and beds of freshwater shells are found above marine accumulations, and followed by the greensand and chalk. At the present time we find peats, and antlers of the red deer, in the bed of the Channel, several miles off Swansea. On the Norfolk coast, and in the English Channel, are found the bones of the elephant, and fossil wood, disinterred from former cliffs by the action of the sea. These, with many other circumstances, were quoted as showing that whilst the sea-level was fixed, the land had suffered depressions and elevations at many periods of time.

Professor **Phillips** pointed out the extent of some of these subsidences of the land; for example, the old red sandstone, 8,000 feet thick, all formed in shallow water, and the coal measures 11,000 feet thick, and added under similar circumstances: and inquired what condition of the interior of the earth can have admitted of the gradual subsidence of such great masses of strata? According to Mr. Hopkins's statement, it was improbable that the interior would *now* admit of it. With respect to the augmentation of temperature which would follow on the addition of several thousand feet of strata, it should be remembered that the communication of heat from below, through such rocks, was remarkably slow; and the law of the distribution of internal temperature could not be assumed the same in ancient as in modern times. As to the level of the sea remaining unchanged, this was only assumed for security in geological reasoning; there was evidence in the Malverns of a sea-level 600 feet above the present, but it was impossible to say whether that ancient level was nearer the *centre of the earth* when formed than now.

Coast Levels.—Lieut.-Col. **Portlock** communicated some observations on apparent changes in the level of the coast near Portsmouth, and contended that, as these evidences of subsidence could be traced back to the most ancient times, so they had continued up to the present day, and expressed his conviction that a parallel might be found in existing nature to all the phenomena of ancient times. It appears that Fort Cumberland, near Portsmouth, stands on a bank of gravel and sand, and that owing to some new wall made to protect it from the sea, a fresh direction was given to the tide, and a portion of the bank undermined and washed away, in the course of which a thick plank with a bolt was discovered, showing that the basis of the fort had no great antiquity. An artesian well has also been made to supply Blockhouse Fort, which shows, for the first 60 feet nothing but clean shingle, and then a layer of sandy clay, full of common oyster-shells.

"*On the Chemical Character of Steel.*" By Mr. **Nasmyth**.

Were we to assume, as our standard of the importance of any investigation, the relation which the subject of it bears to the progress of civilization, there is no one which would reach higher than that which refers to the subject of steel: seeing that it is to our possession of the art of producing that inestimable material that we owe nearly the whole of the arts. I am desirous of contributing a few ideas on the subject, with a view to our arriving at more distinct knowledge as to what (in a chemical sense) steel is, and so lay the true basis for improvement in the process of its manufacture. It may be proper to name that steel is formed by surrounding bars of wrought iron with charcoal placed in fire-brick troughs, from which air is excluded, and keeping the iron bars and charcoal in contact, and at a full red heat for several days; at the end of which time the iron bars are found to be converted into steel. What is the nature of the change which the iron has undergone we have no certain knowledge; the ordinary explanation is, that the iron has absorbed and combined with a portion of the charcoal or carbon, and has in consequence been converted into a carburet of iron. But it has ever been a mystery that on analysis, so very minute and questionable a portion of carbon is exhibited. It appears that the grand error in the above view of the subject consists in our not duly understanding the nature of the change which carbon undergoes in its combination with iron in the formation of steel. Those who are familiar with the process of the conversion of iron into steel, must have observed the remarkable change in the outward aspect of the bars of iron, after their conversion—namely, that they are covered with blisters. These blisters indicate the evolution of a very elastic gas, which is set free from the carbon in the act of its combination with the iron. I have the strongest reasons to think that these blisters are the result of the decomposition of the carbon; whose metallic base enters into union with iron, and forms with it, *an alloy*, while the other component element of the carbon is given forth, and so produces in its escape the blisters in question. On this assumption we come to a very interesting question—What is the nature of this gas? In order to examine this, all that is requisite is to fill a wrought-iron retort with a mixture of pure carbon and iron filings, subject it to a long-continued red heat, and receive the evolved gas over mercury. Having obtained the gas in question in this manner, then permit a piece of polished steel to come in contact with this gas, and in all probability we shall then have *reproduced* on the surface of the steel a coat of carbon resulting from the re-union of its two elements, namely, that of the metallic base of the carbon then existing in the steel, with the, as yet, unknown gas; thus synthetically, as well as by analytic process, eliminating the true nature of steel, and that of the elements or components of carbon.

"*On Hydraulic Pressure Engines.*" By Mr. J. **Glyn**.

This paper described the mode of employing the power of waterfalls in a most useful and important manner—too long neglected in this country, considering the advantages it affords in hilly districts for the drainage of mines. Mr. Glyn brought under their notice the means of employing high falls of water to produce a reciprocating motion by means of a "pressure-engine." The pressure-engine acted by the power of a descending column of water upon the piston of a cylinder to give motion to pumps for raising water to a different level, or to produce a reciprocating motion for other purposes. The pressure-engine was calculated to give great mechanical effect in cases where waterfalls may be found of much too great a height and too small a quantity to be practically brought to bear in a sufficient degree on water-wheels within the ordinary limits of diameter. The author produced instances of the desired pressure-engine, one of which was constructed about forty years ago in Derbyshire—and which he believed was still at work in Alport Mines, to which it was removed from its original situation. The cylinder was, he believed, 30 inches in diameter. In 1841 Mr. John Taylor advised the application of another and more powerful engine at the Alport Mines, which was made under his (Mr. Glyn's) direction at the Butterley Ironworks in Derbyshire. This was the most powerful engine that had been made. The cylinder was 50 inches in diameter, and the stroke 10 feet. It was worked by a column of water of 132 feet in height, so that the proportion of power to act on it was as the area of a piston to that of the plunger—namely, 1,963 to 1,385, or fully 70 per cent. The superintendent of the machinery assured him that the engine had never cost them £12 a-year since it was erected. Its usual speed was about 5 strokes per minute ; but it was capable of working at 7 strokes per minute without any concussion in the descending column, the duty actually done being equal to 163 horse-power :—Area of plunger 9·621 feet × 10 feet × 7 strokes = 673·41. 673·41 × 62·5 × 132 = $\frac{5555632}{33000}{}^{2}$ = 163 horse-power. The author concluded by remarking that, in this case as in all others when water acts by its gravity or pressure, those machines do the best work when the water enters the machine without shock or impulse and quits it without velocity. They thereby obtain all the available power that the water will yield with the least loss of effect; and this result is best accomplished by making the pipes and passages of sufficient and ample size to prevent acceleration of the hydrostatic column.

"*Analysis of Wrought-Iron produced by Cementation from Cast-Iron.*" By Professor MILLER.

It is to be noticed that considerable change in the specific gravity occurred in the iron after cementation : it was forged, and then found to have increased in density ; the brittle iron had a specific gravity of 7·684, the malleable 7·718. The results of analysis were briefly these :—The quantity both of carbon and silicon are materially diminished by the cementation, though still the proportion of both is materially greater than in good bar-iron. It also appears that the portion of carbon which is insoluble in acids is partly the same both before and after the iron has been rendered malleable, the diminution being confined almost to that portion of carbon which was chemically combined with the metal, and which, therefore, would be in a state for propagation through the mass more readily by cementation.

"*On the Drainage of a Portion of Chat-Moss.*" By G. W. ORMEROD.

The *surface* of the moss varies from 80 feet to 100 feet above the sea level ; its *bottom* at the deepest part is 100 feet below the sea line. Part of this moss is now being laid dry by means of open drains, under the directions of Mr. Ormerod. After cutting the drains, the level of the peat falls rapidly ; near the main leader it sank perpendicularly 5 ft. 6 in. in nine months, and in one part 2 ft. 6 in. in a single week.

"*Extraction of Silver from some of its Ores by the Wet Way, with a Notice of a Process as a Substitute for that of Liquation.*" Communicated by Dr. PERCY.

This communication proposes to treat silver ores with hyposulphate of lime and chloride of lime ; and from experiments detailed by Dr. Percy there appears every reason to believe that these substances may be employed economically, and both gold and silver extracted by an easy and effective method. A process as a substitute for that of liquation was also suggested. Mr. Hunt proposed, from the importance in a practical point of this communication, that it be printed entire in the volume of Transactions. Col. Yorke seconded this proposition ; and it was adopted.

"*A new Hydrographic Map of the British Isles,*" by HERR PETERMANN, was exhibited.

On this map about 1,550 rivers are distinguished by names, 480 lakes and ponds, and 40 waterfalls ; the canals with their altitude, as well as that of the rivers and lakes, and the great drains in the fen districts. It was stated that there were 20 rivers in England, 10 in Scotland, and 10 in Ireland, each draining 500 square miles and upwards. Of these—

18 drain an area each = 500 to 1,000 square miles.
14 " = 1,000 " 2,000 "
8 " = 9,000 " 10,000 "

These last eight are—The

Humber (including Trent and Ouse) to Spurn Point	9,550
Severn (to Flat Holmes)	8,580
Shannon (to Loop Head and Kerry Head)	6,946
Thames (including Medway) to Nore Light	6,160
Barrow	3,410
Great Ouse	2,960
Baun	2,345
Tay, as far as Rhynd	2,250

The river Amazon drains a tract of 2,275,000 square miles.

"*On a New Element of Mechanism.*" By Mr. R. ROBERTS.

The writer explained the construction of a contrivance by which he effected in a very simple manner movements for which more complicated mechanism was frequently employed. The model consisted of a steel stock-shaft, on which were fitted two brass discs in such a way as to be kept steady. One of the discs had eleven teeth rounded at the top and bottom in its circumference, and was placed on the body of the shaft. The other disc, which was rather the larger, was in the eccentric position of the shaft, with its face to that of the toothed disc. The plain disc had four studs rivetted into it at equal distances from each other and at such distances as to admit of their being brought successively, by the revolution of the eccentric, to the bottom of the hollows in the toothed disc. The following movements may be effected by this model :—viz., if the shaft be held stationary and the discs be made to revolve upon it, one of the discs will make twelve revolutions whilst the other only makes eleven. Again, if the toothed disc be held whilst the shaft be made to revolve twelve times, the plain disc will revolve, in the same direction, one revolution only ; and if the plain disc be held, the toothed disc will perform one revolution in the contrary direction, for eleven revolutions of the shaft. It would be evident that almost any other number of revolutions may be produced by employing a smaller number of studs, not fewer than three, which will not divide the number of teeth in that disc. The idea of this novel element in mechanics was suggested to Mr. Roberts by a dial movement in an American clock.

MINTS.*

The subject of mints is one on which there is little printed, but Major Smith, of Madras, has brought out a considerable book. This work is mostly directed to the subject of mint accounts, but with this object a close investigation is necessary into the processes affecting the condition of the precious metals in the operation of coining, and this may be found of interest. Major Smith's great purpose is to establish that no loss of *value* of gold or silver can or does take place in coining, and that there is therefore no difficulty, under a proper system of management, of providing an adequate check. He says—

> We consider it beyond doubt, judging from the results of actual experience, that there ought to be no loss whatever by the process of conversion, in any of the Indian Mints ; on the contrary, as we have elsewhere explained, there ought to be a small surplus in the out-turn. In the discussion, therefore, of the duties and responsibilities of the different officers of the establishment, we shall consider this as being admitted, because our object is to determine what the requisite checks are to insure the business being properly executed ; not what may suffice if it be imperfectly done, or slurred over.
>
> Before proceeding, however, it may be advisable that we should first notice and obviate a misconception which has been suggested to us in reference to the above assertion, as it strikes at the very root of all the benefit of the important principle involved in it. It has been said, that it may be very true there ought to be no waste, or even a slight surplus in the re-delivery of the precious metal entrusted to a Mint, provided it were possible to extract all the particles from the mass of refuse wherein they are buried ; that by pushing the recoveries to an extreme length, in defiance of all real economy, it may be in fact possible to exhibit a trifling over-plus, though the cost of the extraction of the last particles may have far exceeded the value of the metal ; but that unless this reckless contempt of true economy be systematically persevered in, as it is clear that a certain amount of bullion must, of necessity, be allowed to remain untouched, on account of the expense of extraction, a waste must be unavoidable ; so that however true in theory, it must be a fallacy in practice to say, that there ought to be a nett surplus of delivery, and an actual *bonâ fide* excess. This argument is, however, based upon a misapprehension of the truth it is intended to oppose, for the assertion is not, that there should be no metal not recovered, but that there should be no metal lost whose existence could not be proved, and its value recovered, if necessary. Further, that as a matter of actual practice, there ought to be a nett surplus of delivery, including the particles in the drosses, whether they be recovered therefrom or whether they be not, which is totally immaterial to the question ; to which it may be added, that this excess ought to be so much larger than the value of all the particles which are not extracted from the refuse, that even taking the matter in the sense in which it is viewed in the objection, the assertion still remains practically true.
>
> The principle and the practice we contend for is, that the out-turn of a Mint in coins, bullion, and drosses, ought to be *exactly* estimated, and compared with its receipts ; and we affirm that if this be correctly done, and the duties of the Mint have been strictly and faithfully performed throughout, the former ought to exceed the latter, whenever the bullion is debited at the "trade Assay." Which being the case, we are of opinion that, as a matter of system, the comparison ought to be made, and the check thereby established, in preference to the more lax proceeding of omitting the comparison, and writing off all deficiencies to profit and loss as "unavoidable waste in the operations of coinage." The extent to which the extraction of the bullion out of the drosses ought to be carried, is another and a very simple question ; the answer to which obviously is, that it should be carried so far, and no farther, than it would be attended by a clear profit to do so. In this way it is that the business is carried on in Madras, the refuse, when no longer capable of being "recovered" on account of Government with profit, being sold, and the proceeds carried to account ; and it is according to this scheme of practice, that the actual results which have been referred to have produced a nett surplus amounting to $\frac{7}{12}$ per mille.

If, however, there ought to be no deficiency of the precious metals, it does sometimes happen : it seems that coins are sent out of the mints too good. Thus it is said—

> We have been informed, that in the year 1845, the coins issued by the

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* "Observations on the Duties and Responsibilities involved in the Management of Mints ; chiefly with reference to the Rules and Practice of those of India. With suggestions for their Improvement." By Major J. T. SMITH, H.E.I.C. Engineers, F.R.S., A.I.C.E., Master of the Madras Mint. Madras, 1848.

Bombay Mint were so much above Standard, that if they may be assumed as being fairly represented by 50 pyx assays made of them at the Royal Mint, and the value of the out-turn calculated thereby, they must have contained very nearly 36,000 rupees worth more pure silver than they ought to have done; a case in point showing the impossibility of the Mint officers guarding against loss, because if it be assumed that the merchants were *fully* paid for their bullion, the Mint must have suffered the loss of the above sum.

With regard to the probability of loss of metal, the author examines whether it could take place in the melting, and he mentions—

There is a greater probability in this process, that a real loss, an actual diminution of value should occur, than in any other. I have above stated that a change of value cannot possibly be effected, except by a literal abstraction of the precious metal, and we can easily understand why such is the case. If a pound of *pure* silver, for instance, were melted a thousand times, and if copper were added to and subtracted from it by successive portions: at every step of these processes, provided none of the particles of pure metal had been allowed to escape, the result of every true assay of the metal, whether in its coarse or fine condition, ought to be such as to make its value equal to that of a pound of pure silver. There is nothing in mere manipulation to alter value, unless some of the precious particles are dissipated; but we might be inclined to suspect that this might occur during fusion. It is not impossible, one would think, that silver might be volatilized, and thus the precious metal be diminished in quantity. It is certain that if any alloy be melted, its weight after fusion is considerably reduced; but it is also eqally certain that, practically, not a particle of silver escapes from the furnace.

This being the only point on which the smallest doubt could reasonably be entertained, I have given it the most attentive examination. When I was in Calcutta in January, 1842, and visited the Mint there, I made particular inquiries as to the volatilization of silver. The very idea of such a thing seemed to be considered absurd, and I was assured that no such thing as volatilization of silver had ever been experienced. It was not the custom to sweep out the chimneys, because the volatilization of silver was out of the question, but I was told that when that metal was adulterated with mercury there was a loss, and particles of the mercury might be evaporated. This is true also in regard to lead, fumes of which escape from silver very frequently. But neither of these would at all change the *value* of the mass in fusion.

The same question has also been practically tested at Madras—and though no such thing as sweeping the chimneys for the purpose of recovering volatilized silver had ever been heard of previously, I determined upon having it done, in order to obtain decisive evidence upon a point of so much importance. The result was, that in the chimney of a furnace which had been in constant daily use for about 15 years, and in which many crores of rupees worth of bullion must have been melted, there were collected particles of silver which altogether weighed about 70 *grains*. This experiment taken in connection with the experience of the Calcutta Mint, seems to my mind to be quite conclusive as to the fact that there is no real loss in melting, by any dissipation of the precious metal.

The following is a practical explanation of one of the causes of apparent loss:—

It is notorious, however, that when silver is melted for coinage, the weight after fusion is considerably less than before, even after making this recovery and every allowance. It is admitted also that the metal undergoes refinement, and consequently that it has become purer in quality than it was. All that I wish to add is, that its value after fusion ought to be precisely equal to what it was originally, and that there is no necessary cause for wastage or loss; and this, because it is simply copper, and nothing besides but copper, or base metal, which is injured by the heat, so as to be separated from the alloy and lost in the refuse, whence it is not worth while to recover it. It is owing to the absence of any means of recognising the minute changes of fineness in the silver alloy, and the consequent adoption of a system of account independent of them, that it has been impracticable to exhibit this truth, or to take advantage of it, in the manner indispensable to avoid waste; and the attention being therefore exclusively paid to that change in the metal which alone is palpable, viz., in its weight, is one of the great causes of the real loss which I inquired into. I propose hereafter to detail the means by which this evil has been rectified; in the mean time I must invite attention to another.

When the Mint receives bullion, it is supposed to receive nothing but solid metal, which is charged to it according to its weight and actual fineness, but I found that these supposed conditions did not always exist, and that the bullion was not always made over to the Mint in the solid state. In some cases coins were received, which were always more or less dirty, and these were calculated in the accounts by multiplying the gross weight of dirt and silver by the average fineness of a sample melted for assay. The consequence manifestly was an unavoidable loss, corresponding with the amount of dirt which had been reckoned as silver, and the remedy was plain, viz., taking care to melt the coins always in future. In this way one of the principal causes of the previous loss was got rid of.

Another case was more serious to the parties.

We may also cite a case which occurred in Bombay, where there was a deficiency between the produce and valuation of a particular parcel of bullion received into the Mint, to the amount of about 1,200 rupees. A committee being appointed to inquire into the deficiency, stated, that the discrepancy was apparent, but as it would never do to doubt the assays, they must conclude the fraud had been practised by the melters. The head melter was accordingly ordered to pay the money, and did so; but it was afterwards plainly shown that the valuation had been made without proper precautions against mistake, and that in so far as the evidence went, there was not the least reason to believe that the quantity of bullion for which the melter had been held accountable had ever been received by him.

In annealing, an apparent increase of weight takes place, which is thus explained.—

The process of annealing is for the purpose of softening the blanks, and making them more fit to receive the impression of the die. It also assists the operation of the acid in cleaning. The blanks are placed in a reverberatory furnace and brought to a red heat, after which they are cooled, either by immersion in water, or by exposure to the air. The effect of this process is a slight increase of weight, owing to the combination of oxygen with the alloy in the metal; and as it is entirely superficial, it varies in its proportion according to the form and superficial area of the pieces exposed to its action. We have not made any experiments with minute accuracy on this point, as the pieces after leaving the laminating and adjusting department are counted on transfer, and thus passed from hand to hand by tale, so that trifling variations in the gross weight cease to be of any importance; but from the experiments which we have made, the difference of weight in rupees has been shown to be about 3 annas $7\frac{1}{8}$ pie per mille, or $4\frac{1}{3}$ pie per cent. As this increase of weight is occasioned merely by the addition of a foreign substance (oxygen) to the metal, it cannot of course, by any possibility, be the cause of any loss of value.

In blanching, a slight difference in the apparent weight takes place, because in some mints grease and oil are used in laminates, which adheres to the metal and is removed by the acid.

Difference of *weight* may take place, but difference of *value* cannot; and it is by adopting this latter test that a proper system of accounts can alone be adopted. We may remark, in conclusion, that the author has laboured very hard and conscientiously in establishing the correctness of his views; and, which excites the more admiration, as having been done under the hot sun of Hindostan and in a state of ill-health.

THE PLATE-GLASS TRADE.

The statistics of the manufacture of plate-glass in England, just published in a tabular form, with a few remarks appended, on a folio sheet, by Mr. Henry Howard, of Plaistow, in Essex, are very instructive.

In 1819 the excise duty on plate-glass was 98*s.* per cwt.; none was made in England larger than 120 inches by 72, the quality was indifferent; the price when 12 inches square was 13*s.* 1*d.* per foot, when 120 inches by 72, it was 160*s.* per foot.

In 1827 the excise duty was 60*s.* per cwt.; plate-glass 144 inches by 75, was manufactured; the quality was considerably improved; the price of plate-glass, when 12 inches square, was 6*s.* 8*d.* per foot, when 114 inches by 75, it was 50*s.* per foot.

In 1847 there was no excise duty on plate-glass; plates 144 inches by 76 were manufactured; the quality was very much improved: the price of plates 12 inches square was 3*s.* 4*d.* per foot; plates 144 inches by 76, cost 35*s.* 6*d.* per foot.

In 1819, when the excise duty was 98*s.* per cwt., the quality of the glass was indifferent, the average price per foot 20*s.* to 25*s.*, the quantity sold per week about 3,000 feet, and the supply apparently equal to the demand.

In 1827, when the duty was 60*s.* per cwt., the quality was improved, the average price per foot 10*s.* to 12*s.*, the quantity sold per week about 5,000 feet, and the supply inadequate to the demand.

In 1847, when the excise duty had been taken off, the quality was very much improved, the average price per foot 4*s.* to 5*s.*, the quantity sold per week about 70,000 feet, and the supply very inadequate to the demand.

In 1836, when the excise duty was 60*s.* per cwt., the estimated number of hands directly and indirectly employed in the manufacture, was about 2,500, the capital invested in it about 250,000*l.*

In 1847, when the duty had been taken off, the number of hands was about 12,000, the capital about 1,000,000*l.*

No comment is required on the tendency of these facts to show how much the manufacture was benefitted by the reduction of excise duties; how much more it has been benefitted by entire emancipation from the trammels of the excise.

Since 1845 foreign plate-glass had been allowed to be imported free of duty. In July 1847, Lord George Bentinck undertook to prove (in Parliament) that the removal of the glass duties had been a failure. He stated that the declared value of glass exported in the first five months of 1845 was 215,630*l.*; in the first five months of 1846, only 131,739*l.* But his lordship omitted to state an important explanatory fact pointed out by Mr. Howard :—" It was in the first five months of 1845 that the duty was remitted, and during that particular period the makers and dealers exported enormous quantities of every description, not on account of increased demand from abroad, but for the express purpose of obtaining the large drawbacks (amounting to bounties) which were then, for the last time, allowed by the excise."

The fact is, that an official return, dated May 5, 1848, printed by order of the House of Commons, shows the total amount of foreign plate-glass, entered for consumption in England, to have been 99,841 feet. This is at the rate of 1,920 feet per week. The number of feet of English make sold per week during that time being 70,000, while in 1845 it was only 23,000. The importation, instead of causing a displacement of English labour, has, by stimulating competition, improved quality and lowered price, and by thus increasing consumption, caused more English labour to be employed.

The state of the exports, as shown by the return already referred to, is equally satisfactory. The exports of English glass in 1847 exceeded those of 1846, in flint-glass, by 20 per cent.; in common window-glass, by 42; in bottles, by 5; in looking-glasses, by 49; and in plate-glass, by 110 per cent. Well may Mr. Howard remark, "Looking at the unexampled commercial difficulties of 1847, this increase is almost incredible."

Two facts relative to the trade in plate-glass, stated by Mr. Howard, have a bearing upon these general results too important to be omitted. Of two agencies established here, exclusively for the sale of foreign plate-glass, one has been compelled to relinquish the sale of it, simply from inability to withstand British competition. There was no English plate-glass exported to the United States in 1846; while, in 1847, it equalled in amount the exports to all the world in 1846.

How, then, are we to account for complaints made both in and out of Parliament that British interests have suffered from the remission of the glass duties? Mr. Howard throws some light on this question :—" In 1845, when the excise duty was remitted, the English makers reduced the price of small plates (which foreigners could not afford to send here at all) to a fair and equitable scale, but the large plates (which, paradoxical as it may appear, cost less per foot than the small ones) were kept up at the unreasonable rates quoted above. Our neighbours, the French and Belgians, attracted and encouraged by the simplicity which thus invited them here, under cover of our excessive prices, accordingly brought over and sold their larger fabrics at enormous profits, whilst our manufacturers, realising still greater advantages, and supported by an immense demand, refused to modify this extraordinary tariff, although its manifest injustice to the public, and direct tendency to injure the very interest it was intended to promote, have been almost universally condemned as the climax of absurdity."

Labour forms directly and indirectly nearly 80 per cent. of the cost of plate-glass. The raw material is nearly all English produce. In short, it is a natural manufacture. As such it was depressed by heavy excise duties, and not relieved by protection from foreign competition. Since it has been emancipated both from the oppressive and the protective influences of fiscal regulations, it has daily grown in strength and prosperity, in defiance of competition. It is only under such a system that branches of industry, natural to a country, can flourish, and such branches of industry only are really advantageous to a nation.

THE GREAT VIADUCT ACROSS THE DEE, IN THE VALE OF LLANGOLLEN.

While the speed to be attained by mechanical ingenuity is being intensely considered, the architecture of our railways is not forgotten, and we feel pleased to have it in our power to notice one of the most daring and stupendous efforts of skill and art to which the railway has given rise. We refer to the great viaduct now in course of completion across the valley of the Dee, in the Vale of Llangollen—the dimensions of which surpass any thing of the kind in the world. While the tubular bridges across the Menai Straits and Conway River are, from their novelty, attracting much attention, the undertaking referred to has proceeded nearly to completion, without any considerable notice being taken of it. Its vastness of proportions may be better conceived, when it is stated that, in magnitude it far exceeds what is considered the greatest effort of human skill in connection with railway communication —the Stockport viaduct. The Dee viaduct (for this is the term given to the one at Llangollen) is upwards of 150 feet above the level of the river—being 30 feet higher than the Stockport viaduct, and 34 feet higher than Menai Bridge. It is supported by 19 arches of 90 feet span, and its length is upwards of 1530 feet, or nearly one-third of a mile. The outline of the structure is, perhaps, one of the handsomest that could have been conceived, both as regards its chaste style and attractive finish; and its general appearance is considerably enhanced by the roundness of the arches, which are enriched by massive quoins, and the curvilinear batter of the piers: this style of architecture imparts a grace and beauty to the structure without impairing its strength. The greatest attention seems to have been paid to the abutments—the only part of the erection, in reality, where any decorative display could be made. In the middle of both, on each side, there are beautifully executed niches in the Corinthian order, in addition to some highly-finished masonry. The piers are neatly wrought at the angles, and at the base of nearly each there is a bedding of upwards of 400 square feet of masonry. With the exception of the entradoes of the arches, which are composed of a blue sort of brick, the whole structure is built of beautiful stone—if not as durable, equal in richness and brilliance to Darlydale. The viaduct has an inclination from end to end of 40 feet, and connects that part of the Shrewsbury and Chester Railway between Rhos-y-Medre and Chirk. Viewed from beneath, the vast structure presents a noble and truly grand appearance, and its bold proportions, with its height, cannot fail to call forth admiration from the most indifferent beholder. While the view below developes what art can accomplish, that from the summit surpasses in richness and luxuriance of the picturesque any landscape in the kingdom. Situated in the middle of the far-famed Vale of Llangollen, there is all that nature and art can bestow to make the view charming and beautiful. On one side are bold and swelling hills, on the other a plain teeming with luxuriance far and wide. Within view are Castell Dinas Bran, or, as it is commonly called, "Crow Castle," which is situate on the crown of a conical hill—the glaciated rocks, Wynnstay, and Pont-y-Cyssyllte, or the Dee Aqueduct. This last structure, which conveys the Ellesmere Canal, is within a short distance from the viaduct, and, from its beauty and extent, imparts additional interest to the locality.

The viaduct has been erected by Messrs. Makin, Mackenzie, and Brassy, contractors, at a cost of upwards of 100,000*l.*, being upwards of 30,000*l.* more than the Stockport viaduct. The cost of the timber required to form the scaffolding, &c., for its erection was 15,000*l.*, and between 300 or 400 masons alone were employed during the whole time of construction. Within a few miles distance there is another viaduct in course of building across the valley of Ceiriog. This structure will be upwards of 120 feet high, and will have 10 arches, of 45 feet span, and one of 120 feet. The entire length will be at least 850 feet, and will cost, when completed, a large sum of money.

NOTES OF THE MONTH.

The Copying Electric Telegraph.—We mentioned in a former number (p. 191 *ante*) that an electric telegraph had been invented by Mr. Bakewell, by means of which a written communication could be copied at a distant town, so as to enable correspondents to recognise the handwriting of each other. This telegraph has, during the past month, had several trials between London and Slough, that line of wire being the only one that can be spared by the Electric Telegraph Company for experiments. The results of these trials have proved that the power transmitted along the wires is quite sufficient for the copying process, as only the same batteries were employed as are necessary to work the needle telegraph. We have seen several specimens of the writing copied along 40 miles of wire, which prove that when the instruments are accurately constructed, copies of any writing may be taken by means of this telegraph. With the model instruments and a single wire, the copying was, we understand, done twice as quickly as communications can be made by the needle with a single wire, and Mr. Bakewell expects to be able to increase the speed ten-fold with larger instruments. Independently of the gain of speed by this means, there would be greater confidence given to telegraphic communications, if the intelligence received were written in the handwriting of correspondents, since by the present mode of communicating there is no proof that the information received is authentic; and as the messages transmitted by the copying process are traced from the original writing, there can be no errors committed by the misunderstanding of signals.

The New Brazilian War-Steamer "Affonso."—The first pair of marine steam-engines built in Bolton, were constructed by Messrs. Benjamin Hick and Son, for the *Affonso*, Brazilian war-steamer, which has obtained such honourable notoriety by the services it rendered to the passengers and crew of the *Ocean Monarch*. These engines are made on the direct-acting principle, are 300-horse power, and several improvements have been introduced in their construction. The framing for supporting the paddles and intermediate shafts is made of forge or wrought-iron, and some idea may be formed of the value of this improvement, by comparing it with the ordinary cast-iron framing generally adopted. One of these pedestal blocks, of which there are four, when shaped and finished, weighed 28 cwt.; but if made of cast-iron, and equally strong, the weight would have been 80 cwt., and even then the liability to fracture would be more than trebly hazardous. There is, also, in the construction of these engines, a simple and improved arrangement of the eccentric and reversing motion, which enables the valves to be reversed for going ahead or astern with the greatest ease, and by which the labour of three men to each engine is saved when reversing. The mode of introducing the injection water is also new, simple, and effective. The *Affonso* was built for navigating the shallow rivers of the Brazils, and she is well armed for the protection of their trade, having a 64-pounder fore and aft, which swivel on carriages, and also four 34-pounders in her side ports. The vessel and engines were built under the orders and inspection of Admiral Grenfell, the Brazilian consul at Liverpool, and though from her construction she was not expected to sail more than 9 knots per hour, she accomplished 11½ on her trial trip.—*Liverpool Mercury*

The Britannia and Conway Bridges.—The report of Mr. Stephenson, presented to the meeting of the Chester and Holyhead Railway, on the 24th ult., stated that the construction of the second tube of the Conway-bridge is far advanced, and there is no doubt it will be ready for removal by the middle of October. The pontoons have been strengthened, the capstans re-erected, and every other arrangement in a forward state for its erection. About three-fourths of the masonry of the Britannia-bridge have been completed; and, taking the progress now making as a guide, it is calculated that the first tube will be ready for lifting to its place in the course of next March or April. The iron-work at the Britannia-bridge has progressed even more rapidly than was expected, and the four large tubes are just approaching completion. The whole of the central portion of the tubes is finished, and the castings at the ends are now being inserted. The scaffolding for the end tubes on the Anglesea side is complete, and a large proportion of the iron is already punched for their immediate commencement. The scaffolding necessary for the tubes on the Carnarvon side will be erected immediately, to open the line throughout as rapidly as possible. Every arrangement is being made for floating the tubes as soon as the masonry is ready. The works throughout the whole of the line are standing in the most satisfactory manner. The daily passage of heavy trains through the Conway tube for four months, together with a series of careful observations as to the effects produced, have completely established the correctness of the views upon which the designs for this and the Britannia were based. The cost of these structures has very much exceeded what was originally calculated upon; on re-considering, however, the whole subject, Mr. Stephenson is satisfied that the method which has been adopted is certainly the most eligible, if not the only practicable one.

Mode of Extinguishing Fires at Sea.—The following letter has been addressed by Dr. Reid to a daily morning paper:—"As the danger from fire at sea is attended with so many appalling circumstances (of which we have had a recent instance in the melancholy catastrophe of the *Ocean Monarch*), I beg to submit for the public consideration, and especially underwriters, the following plan, as a cheap, simple, and efficient method of preventing the occurrence of such accidents. Flame or combustion cannot go on where there is carbonic acid gas. This is one of the elementary principles of chemistry. It may be shown in various ways. A lighted taper plunged into a jar of carbonic acid gas is instantaneously extinguished; or, if we take the glass of a common argand burner, and close the upper end of it by a flat plate of glass, or even by a piece of card or pasteboard, firmly, so completely as to prevent any current of air through the tube, on introducing for about an inch or so the flame of a candle at the other extremity (the glass of the argand burner being held upright) it will, usually in the space of little more than a minute, be extinguished, merely by the accumulation of the carbonic acid gas produced by its own combustion. The production of carbonic acid gas is completely at our command, for on adding dilute sulphuric acid to chalk, we can set at liberty, in the space of two or three minutes, enormous volumes of this so-called fixed air. The cost of material for a ship of 1,000 tons would not exceed 15*l.* or 20*l.* sterling By means of tubes proceeding from the upper deck in connection with a cistern containing the dilute sulphuric acid, to the quarters below where there is most likelihood of danger from fire, or moveable hose (made of gutta percha), which can be introduced into any part of the vessel—the oil of vitriol, previously diluted with water, can be at once poured over the chalk (which is to be thrown down in the place where the fire rages), and immediately, the carbonic acid being set at liberty, the fire is extinguished; for combustion cannot go on in an atmosphere of carbonic acid gas. I have been much occupied experimenting on this subject, and find that from five tons of chalk, as much carbonic acid gas may be obtained as will be sufficient to completely fill a vessel of 1,000 tons burden. The expense of laying the tubes will not exceed 30*l.* or 40*l.*; and, once laid, there is no further trouble or expense. I may observe also (but experiments are at variance on this subject) that it is not requisite to have an atmosphere absolutely consisting of carbonic acid gas to extinguish flame, for some experiments show that a taper does not burn in an atmosphere of three parts atmospheric air and one part carbonic acid gas. Lightning-conductors are provided for ships—surgeons also to take care of the health of the crew—assuredly no expense (and it is but a trifle) would be grudged to secure a ship and its passengers from the contingency of such a melancholy mishap as that of fire. If this method will do—and there seems to be everything in its favour—all our emigrant ships, indeed every ship, ought to be secured against a calamity which really must be held as the most dreadful that can occur to a vessel at sea."

South-Eastern Railway.—The works at London Bridge for enlarging the station and widening the Greenwich Railway viaduct, suspended during the monetary panic of 1847, have been resumed. The bridge to cross Bermondsey-street is rapidly progressing. The Gravesend branch is also in a very forward state. It is expected to be opened for public traffic early in the spring.

Railway Signals.—Another of the many contrivances suggested for enabling passengers in railway trains to communicate with the engine-driver or guard, has been recently patented, though it differs little from several others of the same kind. The patentee is Mr. Richard Baird, of Dundee, and he claims the application of tubes to railway carriages, and the combination of cords, wires, or chains with the tubes, in such manner that either the passengers or guard may sound the steam-whistle. It is proposed to connect the cords passing through the tubes under each carriage by spring hooks.

Great Western Docks, Plymouth.—These docks are being proceeded with rapidly, and, when completed according to the design, will furnish accommodation superior to that afforded by any docks of similar extent. The inner basin, or floating dock, will be capable of containing and affording ample wharfage for 12 steamers of the largest size, a number, we believe, equal to that accommodated by the great basin at Portsmouth, recently opened. There will be two entrances to this basin; one will admit merchantmen of the largest size, and steamboats of ordinary dimensions, for two or three hours before and after high water—through the other the largest screw-steamer can pass at high water. The area of the outer basin will be nearly 30 acres. If this basin should be deepened to the extent proposed, vessels can enter and be afloat in it at all times of the tide without the delay of pasing through a lock. This is an advantage not possessed by Liverpool, and many other ports. The entire extent of wharfage will exceed a mile, and the area of ground for stores is adequate to the greatest possible trade.—*Devonport Chronicle.*

Birkenhead Docks.—It appears by the *Liverpool Times*, that the most active preparations are going on in the engineer's department of these works, in the preparation of working drawings, &c., for the recommencement of the construction of the docks forthwith. Arrangements, it is said, have been made for raising the requisite capital, and no doubt remains as to the successful accomplishment of the object of the new trust. An important trade is opening up in the exportation of coal from the Welsh mines, which can be brought, it is said, to Birkenhead docks, and put on board vessels at very considerably less cost, and with far greater facility, than from the Lancashire coal-field.

The Grimsby Docks.—These are mighty works, and are proceeding with most satisfactory rapidity, alike creditable to all concerned. The chief engineer, Mr. Rendell, is expected shortly; but the engineer, Mr. Adam Smith, who is very properly called the resident engineer, is always on the works. There is a defect, or rather a sinking, in one portion of the piles from the "blow sands"—a name upon which tradition has exhausted its ingenuity, and has summed up all by ascribing to demoniac agency the "fathomless pit." Shakspeare was right in putting into *Hamlet's* soliloquising thoughts, "Oh, what a mighty piece of work is man!" and had he lived to see the mighty pieces of work which man achieves, some other as appropriate exclamation would by him have been furnished. One hundred and fifty acres taken from the sea, and defences raised to prevent the mighty ocean claiming back "its own," and such defences as will resist its foaming rage, let its battering waves lash it as they may—borrowing from some of its sister land chalk as the means of defence, of which no less a quantity than 10,000 tons are every week conveyed on a road of iron. By October, it is expected all will be ready to receive his Royal Highness Prince Albert, to lay the first stone of the intended Royal Albert Grimsby Docks; and, within three years, a dock of 37 acres will be ready to receive vessels laden with foreign stores. So much progress could not have been made but for the perseverance of Mr. Adam Smith, and those under his directions.—*Nottinghamshire Journal.*

Clifton Suspension Bridge.—Upwards of £40,000 have already been expended upon this undertaking, and no more money being forthcoming the works are now at a stand-still.

Improvements in Bridge Building.—A fine wooden bridge has recently been erected by the Cambuslang-road trustees, across the river near Dalmarnock, to supply the place of the old one, which is now 30 years old, and very much decayed. The new bridge was commenced only five months ago, and was built from a design by Mr. Robson, C.E. The whole length of the bridge is 355 feet, and the width within the side-rails is 28 feet. There is a footpath on each side, covered with asphalte pavement, and the road-way is composed of a mixture of asphalte and whinstone metal, broken, 7 inches deep, and laid on the top of the planking, which had been previously well caulked with oakum, and coated with pitch and sand, for the purpose of making it water-tight.

Circular Sawing.—An experiment has been lately made at the Saw-mills, Woolwich-dockyard, with the view of testing the efficiency of circular saws in cutting through the centre of rough timber of a diameter nearly equal to that of the saw itself. An elm tree—one end of which was of the full diameter of the saw—was placed upon one of the circular sawing machines, having a saw 4 feet diameter, and a self-feeding motion, in the usual way. By this motion the tree was brought towards the saw, and passed over it; and by a reverse motion, it was turned back. The cut made in the tree, passing over the saw, was in dead wood all the way, and fully 20 inches deep. After the tree was run back, it was turned over, and adjusted for a second cut, to line with the first; and in this position it was brought forward, as before, and completely divided in two.

Method of Welding Iron, Steel, and Sheet-Iron.—In an earthern vessel melt borax, and add to it one-tenth of sal-ammoniac. When these ingredients are properly fused and mixed, pour them out upon an iron plate, and let them cool. There is thus obtained a glassy matter, to which is to be added an equal quantity of quicklime. The iron and steel which are to be soldered, are first heated to redness, then this compound, first reduced to powder, is laid upon them; the composition melts and runs like sealing-wax. The pieces are then replaced in the fire, taking care to heat them at a temperature far below that usually employed in welding; they are then withdrawn and hammered, and the surfaces will be found to be thus perfectly united. The author asserts that this process, which may be applied to welding sheet-iron tubes, never fails.—*Mechanics' Magazine.*

The South-Foreland Lighthouses.—These edifices are now completed, and their appearance reflects credit on all parties concerned in their erection. There are two—the one called the Upper, and the other the Lower South-Foreland Lighthouse. The headland on which they stand is the nearest point in England to the coast of France, the distance being barely 21 miles across the Channel. The upper lighthouse consists of a massive tower (externally octagon, internally circular), the lanthorn of which is about 375 feet above high-water mark, leaving a perpendicular height of the cliff on which it is situated of about 290 feet. The lanthorn is constructed on a novel principle. It is furnished with 264 mirrors, which are inclosed on the side opposite the sea by six lenses. These mirrors, casting a multitudinous reflection on each other, afford a stong and brilliant light, being clearly visible on the opposite coast, throughout the Downs, Ramsgate, and even Margate, and the greatest portion of the Isle of Thanet. The lamp, which is in the centre of the lanthorn, consists of one large socket, containing four burners; and it supplies itself with oil by means of a kind of clock-work machinery, which, while it pumps up the oil to the wick, also returns the surplus quantity to the reservoir; and in case of any defects, or want of supply, by a small hydraulic balance, strikes a sharp tinkling bell, as a warning to the keeper. The machinery is very simple, and at the same time curious. The lanthorn consists of a cupola, the roof and sides of which are composed of neatly wrought-iron frames, apparently light, but sufficiently strong to stand against the tempest. It is enclosed by 48 oblong panes of plate-glass, from 2½ to 4 feet long. Around the cupola, on the exterior, is a balcony, rendered safe by a castellated parapet, from which, in clear weather, a splendid view is obtained. Passing from the upper lighthouse, about a quarter of a mile easterly, is the lower one, standing on the verge of the cliff. The tower is not so high as the former, neither is it lighted on the same principle. Within the lanthorn are suspended from copper branches 15 Argand lamps, each having a burner of rather large dimensions with a concave reflector of the greatest brilliancy, and about 20 inches in diameter. It appears that it is yet a matter of doubt which system of lighting is preferable, but the Corporation of Trinity are giving each a fair trial.

The "New Star," Steamboat.—Some experiments were tried on this vessel, on the river Thames, on the 27th ult., preparatory to the building of a new iron steamer. The trials were highly satisfactory, an average speed being attained, after several trials at the mile distance at Northfleet, of 13 miles per hour in dead water. The engines and vessel were manufactured by Messrs. Miller and Ravenhill. Tonnage, 265; oscillating engines of 68-horse power; diameter of cylinders, 34 inches; length of stroke, 2·9; number of revolutions per minute, 48.

Launch of a Steam-vessel in the Thames for Service in Scotland.—A very handsome-built iron boat was launched, on Saturday, the 16th ult., from the building-yard of Miller, Ravenhill, and Co., Orchard-wharf, Blackwall. This is the third vessel turned out by the above firm for the Edinburgh and Northern Railway Company; the two former vessels being known as the *Auld Reekie*, and *Thane of Fife*. The new craft is expressly adapted for the passage across the Frith of Forth, and will have a speed superior to the former squadron. She was christened the *Express*, and will be furnished with a pair of oscillating engines of 120-horse power, a pair of feathering wheels, tubular boilers, &c., which are now erecting on board. Her length is 150 feet between her perpendiculars; breadth, 148 feet at load line; depth, 11 feet; draught of water, 6 feet.

Alleged Propulsion of a Vessel by Steam in the Year 1543.—M. Gonzales, director of the Royal Archives of Simancas in Spain, published in 1826 an account of an invention by Biasco de Garay, a naval captain, who, it is stated, exhibited in Spain, in 1543, an engine, by which ships of the largest size could be propelled in a calm without the aid of oars or sails. He made an experiment before commissioners, appointed for the purpose of examining his invention at Barcelona, on the 17th of June, 1543—the vessel used being a ship of 200 tons. Garay, we are informed, wished to keep his mechanism a secret; but it was observed to consist partly of a large cauldron, or vessel of boiling water, and of two moveable wheels, one on each side of the ship. The experiment succeeded so far, that the vessel was propelled at the rate of two leagues in three hours; and the inventor was rewarded by receiving a sum of 200,000 maravedis, besides having his expenses defrayed from the public treasury. It is added, that the invention would have been further encouraged had not State expeditions of great consequence claimed the immediate attention of the emperor. And it is important to mention, that the authenticity of the entire history of Garay's invention, as published by Gonzales, has been called into question, and that no practical results of any utility followed. *Frazer's Magazine.*

Gutta Percha Boats.—At Seacombe, a No. 1 pilot boat, built of gutta percha has been tested. It is 17½ feet long, and though nearly filled with water, and having four men on its gunwale, kept its buoyancy. It weighs 190 lb. and sustains a pressure of 15 cwt. It not only answers the purpose of a pilot-boat, but is also convertible into a life-boat. This substance must make an excellent life-boat; and before we saw the above account, we had thought of calling attention to the feasibility of this application. The toughness, elasticity, and lightness of this material, for the purpose of boat-building, is unquestionable. The price is one dollar per pound, and 30 pounds must make a boat of a moderate size. The old gutta percha can be sold at a reduced price.—*Scientific American.*

Indian Waterfall.—Among the cliffs of the Eastern Ghauts, about midway between Bombay and Cape Comorin, rises the river Shirawati, which falls into the Arabian Sea. The bed of the river is one-fourth of a mile in direct breadth; but the edge of the fall is elliptical, with a sweep of half a mile. This body of water rushes at first, for 300 feet, over a slope at an angle of 45°, in a sheet of white foam, and is then precipitated to the depth of 850 feet more into a black abyss, with a thundering noise. It has, therefore, the depth of 1,150 feet! In the rainy season the river appears to be about 30 feet in depth at the fall; in the dry season it is lower, and is divided into three cascades of varied beauty and astonishing grandeur. Join our fall of Genesee to that of the St. Lawrence, and then treble the two united, and we have the distance of the Shirawati cataract. While we allow to Niagara a vast superiority in bulk, yet in respect to distance of descent it is but a mountain rill compared with its Indian rival. —*Rochester Democrat.*

The American Lakes.—Professor Drake, of Cincinnati, has been making some observations upon these inland seas, and gives the results to the public. The chain of lakes extends over nearly eight and a half degrees of longitude in length. The extent of their surface is estimated at 93,000 square miles; and the area of country drained by them is computed at 400,000 square miles. Their relative sizes are as follows:—"Ontario, 5,300 square miles; Erie, 9,600; St. Clair, 360; Huron, 30,400; Superior, 22,000. The average depth of water in the different lakes is a question upon which there is no certain information. Authorities differ. Dr. Drake gives it as follows:—St. Clair, 20 feet; Erie, 84; Ontario, 500; Superior, 900; Huron, and Michigan, 1,000. In standard works, Lake Erie is usually stated to have a depth of 120 feet. The depest soundings have been made in Lake Huron. Off Saginaw Bay, 1,800 feet of line have been sent down without finding the bottom. The altitude of these lakes varies step by step from Ontario to Superior. Lake Ontario is 232 feet above the tide-water of the St. Lawrence. Erie is 333 feet above Ontario, and 565 feet above the tide-water at Albany. St. Clair is 6 feet higher than Erie; Huron and Michigan are 13 feet above St. Clair, and Superior lies 44 feet above them. This shows the curious fact that while the surface of Huron is 684 feet above the level of the ocean, its bottom, at Saginaw Bay, is more than 1,100 below the same level. The waters of these lakes, with the exception of Erie and St. Clair, are remarkable for their transparency and delicious flavour. Of Lake Huron, Professor Drake ascertained that the water at the surface, and 200 feet below the same place, indicated precisely the same temperature,—namely, 56°. His explanation of this fact is: the waters are so pure that the rays of the sun meet with no solid matter in suspension to arrest and retain the heat."

New Cement.—The *Buffalo Journal* describes a valuable cement, which was first discovered in Sharon, Medina county, Ohio, and, after undergoing the most thorough test, has been pronounced of great value for cementing roofs of buildings, steamboat decks, &c. The mine itself (says the *Cleveland Herald*) is one of the most singular depositories to be found. It seems as if poured into a large sand-stone basin, covering some four acres, is found at the depth of 20 feet, presents an even level surface, is about 5 feet thick, and when dug out is no harder than tallow, and is entirely free from dirt and other impurities. An exposure of two weeks to the air changes the cement to stone, so hard, that it is difficult to grind. In preparing it, the cement is first ground when green, and after it has been hardened, it is ground again, and remains in a powdered state until mixed with oil for use. When applied to roofs, it becomes hard and durable as slate, and is a certain fire-proof, and is in no way affected by the weather. We have been shown a specimen of the cement that has been on wood nine months, which adheres closely, is as hard as the slates used in schools, shows pencil marks equally as well, and has the grit of a fine hone. The cost is small, being 3 dollars per cwt., which, with the same amount of oil, is sufficient to cover 1,200 square feet.

A Portrait of Mr. T. Cubitt, by Pickersgill, has been subscribed for by the Builder's Society.

Salt.—A spring of brine has just been "tapped," by Mr. B. Smith, at Droitwich, Cheshire, at the depth of 217 feet—being a greater depth than any before discovered; the usual depth being 170 or 180 feet.

On the Occurrence of Vanadium in the Refinery Slag of Staffordshire.—Mr. Deck, in a communication to the *Chemical Gazette*, says—"Being commissioned by an eminent English railway engineer, who has directed much attention towards the qualities of iron employed in bridges, &c., to examine some refinery slag, which, without any assignable reason, had the property of imparting extraordinary ductility to the iron with which it was mixed, I have succeeded in discovering a large quantity of vanadium, existing as silicate of vanadic acid, combined with small portions of molybdena, chrome, and the usual quantities of phosphoric acid and silicates. The first metal being confined to few localities, has had its properties but little studied by English chemists, and has hitherto been found in no other slag than that from the Taberg mine in Sweden, the iron of which is remarkable for its ductility; and no mention is made of it in Dr. Percy's elaborate analyses of slags for the British Association. The quantity of slag at my command operated upon was very small; but the vanadium existed in a much larger proportion than in the Swedish slag, which I have since examined; and it is, doubtless, the cause of the superior ductility of both."

A New Method of Cutting Trenches for Drain Tiles has been invented by Mr. White, of Kennington-road; it is for the purpose of slicing-out the earth, of just sufficient width for the admission of the pipes, instead of the unnecessary and expensive plan at present (from necessity) in use, of digging a trench large enough for the men to work in, perhaps, 2 feet broad, when it may require only a 4 inch, or, at most, a 6-inch drain. The machine consists of two large wrought-iron wheels, of any required diameter, $1\frac{1}{2}$ inch thick at the centre for 12 inches diameter, then tapering to a knife-edge, which is to be hardened steel. These are fitted in a frame, immediately behind each other, but sideways, such a distance apart as to suit the diameter of the pipe intended to be employed. They turn, however, rather closer at bottom than at the top, in order to render the cut of a tapering form smallest at bottom, for the more ready removal of the earth. The implement is drawn by horse-power backwards and forwards, in the direction of the cutting, until the necessary depth is required. As these knife-wheels would cut much better, by having a jet of water dripping upon the earth to be cut, a cistern is proposed to be carried upon the frame. To give increased—indeed, double—power to the horses, when the friction would be very great, a small anchor is to be fixed in the ground, at any distance, for a single piece of cutting—a rope from which would pass through a pulley on the machine, and the horses pull from that end of the rope; the earth is afterwards removed by a peculiar plough. Supposing the implement to travel at the rate of $1\frac{1}{2}$ mile per hour, and that it had to pass over the ground three times to produce the required depth, and that the distance between the drains is 30 ft., in 10 hours it would cut 18 acres.

Smelting Copper.—A correspondent of the *Mining Journal* gives the following process as adopted at Toraas, in Norway:—The ore, which is the common copper pyrites, containing a large proportion of sulphur, when brought from the mine, is spalled to about the size of a walnut. A round kiln, built of dry stones, about 3 feet high, with apertures at short intervals, is constructed; two cubic fathoms of wood are laid in the bottom; on this the ore is placed; this quantity of wood, in general, is supposed to be sufficient for the calcination of 100 tons of ore. When lit, the mass generally burns for three weeks; towards the close of the operation, smalls are thrown on the pile, to prevent the too rapid calcination of the ore. As soon as the fire has ceased, the kiln is opened, and the ore is then wheeled to the smelting-works; if properly calcined, it has a dark red appearance, and is exceedingly friable; great care is required in this operation, as too much heat will cause the ore to melt, and a regulus will be formed. The ore is, in general, allowed to remain three or four days, previous to its being forwarded to the ulterior operations. It is then melted in a common blast-furnace, similar to those used in the Hartz, and other parts of Germany; it requires there about 70 cubic feet of charcoal to smelt 8 cubic feet of copper. The regulus produced from this operation is from 15 to 20 per cent. produce, has a coarse open grain, and, in general, a deep purple appearance. This is subsequently calcined six times; a semicircular kiln, about 6 feet long by 2 feet broad, with an aperture at the end, is built; 4 fms. of wood is in general required to the produce of 100 tons of ore; each calcination takes about 24 hours. After undergoing these calcinations, the regulus assumes, when broken, a white appearance, with a close grain, somewhat similar to white metal. From thence it is taken to the copper furnace, and after remaining there 12 hours, is tapped out in the form of rose copper *(gahn kobber)*. The produce of this is about 94 per cent.

Wood Carbonised by High-Pressure Steam.—M. Violette, commissary of the government gunpowder works at Esqueros, has communicated to the Paris Academy of Sciences a process he had adopted for making charcoal suitable to the manufacture of the best kinds of gunpowder. He finds that at a temperature of 200° centigrade = to 392° Fah., wood does not carbonise; that at 250° centigrade = to 482° Fah., an imperfect charcoal alone is obtained, formerly called *brûlots*, or burnt wood; that at 300° centigrade = to 572° Fah., the red charcoal is produced; and that, at 350° centigrade = to 662° Fah., and above, the operation invariably furnishes the black or complete charcoal. The time necessary for carbonization, he found to vary from three hours to half an hour, and the products passed from red charcoal to black progressively. He also took account of the produce of the charcoal, and found it to diminish in quantity in proportion as the carbonization was carried to a more advanced stage. The quantity of wood usually operated upon by M. Violette was 25 kilog. = $\frac{1}{2}$ cwt., and the wood employed, the blackthorn (*rhamnus frangula*).

Fossil Tree.—A few days since, the workmen employed in the railway-cutting near the Coalbourn Brook, Staffordshire, discovered a fossil tree, in a perpendicular position, in the lime and iron-stone formation called *clunch.* It was 20 inches in diameter, and the top as flat as if regularly sawn off, while, in weight and hardness, it resembled iron-stone. A piece, of 4 feet in length, has been sent to Enville-hall, to enrich the Earl of Stamford's museum; the lower part still remains, but its length has not yet ben ascertained.

A Coal Bed on Fire.—Under the village of Lower Haugh, near Rotherham, Yorkshire, an extensive bed of coal has been burning for twenty years, and threatens to destroy the village by undermining the foundations of the houses. The heat is very sensibly perceptible at the surface, and the inhabitants take advantage of it as a natural hot-bed for raising early vegetables. The sulphurous smell and smoke, however, form a great drawback to this privilege, and indeed render some of the houses scarcely habitable. The coal was ignited at a part where it "bassets out," by making a large fire there for the purpose of burning stones intended for road materials.

The "Great Britain" Steam-Ship.—This celebrated vessel, with her machinery, sails, anchors, cables, &c., was put up for sale by auction, at Liverpool, on Monday, the 18th ult., at which port she has been since September last. The "Great Britain" was built at Bristol, in 1844, by the Great Western Steam-Ship Company, for the New York trade: she was 3,442 tons, registered old measurement; her length of keel and fore-rake, 286 feet; ditto over all, 319 ft. 3 in.; beam, 50 ft. 4 in.; depth 32 feet. She was propelled by engines of nearly 1,000 horses'-power, and fitted with Woodcroft's patent screw propeller; and has accommodation for 250 cabin passengers, with stowage room for 800 tons cargo (measurement), and 1,200 tons coal. Her great strength enabled her to withstand the shocks of the heaviest seas, while stranded in Dundrum Bay, on the northern coast of Ireland, throughout a whole winter, without in the slightest degree altering her lines. The damage done to the engines and ship's bottom has been carefully estimated, after surveys by competent engineers and ship-builders, and, for a moderate sum, the whole ship and machinery might, it is stated, be restored to the original condition. With a smaller pair of engines, capable of propelling her at a slightly reduced speed, by which her coal stowage would be reduced one half, she would accommodate over 1,000 emigrants for a distant voyage. The spacious sale-rooms of Messrs. Tongue and Curry, were densely crowded with merchants from all parts of the kingdom—there being at least 300 gentlemen present. Mr. Curry said, he was instructed to put the vessel up at a certain price, for the parties by whom he was employed, but he should prefer an offer from the company present. Some time having elapsed, the auctioneer informed the company that 20,000*l.* were offered for her. Another pause then ensued, when he said he should take her in, on account of the owners, at 40,000*l.* During the progress of the sale, it was stated in the room, that if from 30,000*l.* to 35,000*l.* had been bid for the vessel, she would have been sold. She originally cost 125,000*l.*

The New Park at Battersea.—The new park at Battersea, which has been for some time in abeyance, will be commenced without delay, notices having been conveyed on the 16th ult. to all the residents on the spot, that they must quit possession, the intention being at once to remove the houses. The water-works will remain. The park will extend the whole distance between Battersea Bridge and Nine Elms, and from the bank of the river to the public road across Battersea Fields, making the length of the park about two miles and a quarter, and its width a little more than a mile. A carriage-drive forty feet in breadth will be formed along the bank of the Thames, and a suspension-bridge will be thrown across the river to the spot where the Red House now stands. Towards the construction of this bridge the Marquis of Westminster has contributed the sum of 60,000*l.* At the south-western boundary of the park an elegant church has been erected, and will be ready for consecration in the course of the present autumn.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM AUGUST 22, TO SEPTEMBER 21, 1848.

Six Months allowed for Enrolment, unless otherwise expressed.

Hugh Lee Pattinson, of Washington-house, Gateshead, Durham, chemical manufacturer, for "Improvements in manufacturing a certain compound or certain compounds of lead, and the application of this and certain other compounds of lead to various useful purposes."—Sealed August 22.

Alfred Vincent Newton, of Chancery-lane, Middlesex, mechanical draughtsman, for "certain Improvements in dressing or cleaning grain, and in separating extraneous matter therefrom." (A communication.)—August 22.

Edward Deuch, of Hurstperpoint, Sussex, hot-house builder, for "Improvements in the roofing conservatories, hot-houses, and other like structures."—August 26.

William Young, plumber, and Henry Burgess Young, engineer, both of Barnstaple, Devon, for "Improvements in smelting and refining lead ores."—August 28.

Charles Rowley, of Birmingham, Warwick, button-manufacturer, for "Improvements in the manufacture of buttons."—August 28

Elizabeth Chrees, of Homerton-Castle, Homerton, Middlesex, for "Improvements in the manufacture of sealing wax."—August 29.

Peter Wright, of Dudley, Worcester, vice and anvil manufacturer, for "certain Improvements in the manufacture of vice-boxes, and in the machinery for effecting the same."—August 31.

George Nasmyth, of Ebury-street, Pimlico, Middlesex, civil engineer, for "certain Improvements in the construction of fire-proof flooring and roofing, which improvements are also applicable to the construction of viaducts, aqueducts, and culverts."—September 4.

William Wheldon, engineer to Messrs. John Warner and Sons, of Jewin-crescent, London, brass-founders and engineers, for "Improvements in pumps or machinery for raising or forcing fluids."—September 4

John Lewis Ricardo, of Lowndes-square, Middlesex, Esq., M.P., for "Improvements in electric telegraphs, and in apparatus connected therewith."—September 4.

William Edward Hollands, of 73, Regent-quadrant, Middlesex, dentist, and Nicholas Whitaker Green, of 15, Walton-place, Chelsea, gentleman, for "a new manufacture of artificial fuel in blocks or lumps."—September 4; four months.

William Losh, of Newcastle-upon-Tyne, for "Improvements in steam-engines."—September 4.

Henry Smith, of Vulcan-works, West Bromwich, for "Improvements in the manufacture of railway wheels."—September 5.

William Dickinson, of Blackburn, Lancaster, machine-maker, for "certain Improvements in, and applicable to, looms for weaving."—September 11.

Robert Walter Winfield, of Birmingham, merchant and manufacturer, and John Ward, of Birmingham, aforesaid, a workman in the employ of the said Robert Walter Winfield, for "certain Improvements in the manufacture of tubes and in the manufacture of certain articles made in part of tubes."—September 14.

William Sager, of Rochdale, Lancaster, wool-dealer, for "certain improved means and apparatus for effecting the transit or conveyance of goods, passengers, and correspondence, by land or water, and for other such purposes, part or parts of which means and apparatus constitute a new and improved method of generating steam, which improvement is applicable to other purposes to which steam is generally applied as a motive power."—September 15.

William Brown Roof, of Stanhope-street, Regent's-park, chemist, for "certain Improvements in the construction of respirators."—September 21.

Henry Wilson, foreman to Messrs. William Greaves and Son, of the Sheaf-works, Sheffield, for "Improvements in the manufacture of chisels and gouges."—September 21.

Joseph Lillie, of Manchester, engineer, for "certain machinery or apparatus applicable for purifying and cooling liquids, and for purifying, condensing, and cooling gases."—September 21.

John Frearson, of Birmingham, machinist, for "Improvements in bending or shaping iron or steel, and other metals."—September 21.

CANDIDUS'S NOTE-BOOK,
FASCICULUS LXXXVII.

> "I must have liberty
> Withal, as large a charter as the winds,
> To blow on whom I please."

I. I lately called attention to a very feasible improvement, or rather, highly desirable completion, of an important public edifice —namely, Somerset-place; and my remarks appear to have been not entirely thrown away, since they have been noticed by others. I will now mention another building—a public one, of considerable importance, and admirably situated in many respects, it having among other advantages, that of being placed directly at the extremity of a vista from one of the most frequented thoroughfares in the whole metropolis. Notwithstanding all which, it is in itself a most flagitious architectural monstrosity. Can any one, after this, be at a loss to guess what is the building which I allude to? I myself know of no other so situated, precisely at the end of a vista whose sides enclose it. After this, and my calling it a perfect monstrosity, can you possibly be any longer in doubt? Those who still are so, ought to be left sticking fast in it, and left to help themselves out of it as well as they can. Don't be in a hurry, good folks; take your time, or take a map of London, and examine it, and then—Oh! you have found it out, have you? you guess that I allude, after my own rigmarole fashion, to the front of Guildhall. Well! since there is no denying it, I confess it: it is the front of Guildhall that I mean,—and both mean and unmeaning enough it is in itself. Civic taste runs more in favour of turtle soup than architecture, or the citizens would abridge the number of their annual tureenfuls of that luxurious fare, in order to accumulate funds for a worthy exterior to their banqueting-hall. As far as it goes, their taste is unexceptionable, but it does not go far enough; it is very palatable, but not at all palatial,—at least, not externally, the exterior of their Hall of Guild being as tasteless as can well be conceived. Instead of turtle, venison, and champagne, it announces water-gruel and cag-mag; it being the most veritable architectural cag-mag ever produced. Some of the city folks must, I think, have longed to carry off the Victoria porch from the Palace of Westminster, and plant it as a portal before their Guildhall, with such addition as might be found requisite for filling up the entire frontage. What that last may be, I cannot undertake to say,—there being no published plan from which measurements can be ascertained. However, that we should there have a *fac simile* or duplicate of the Victoria porch at Westminster, is not at all to be desired. We might be very well content with something of similar character in regard to nobleness of idea and grandeur of design. Yet, so long as there is no absolute occasion for doing anything to the building, nothing is likely to be done; wherefore, one is almost tempted to regret that it was not burnt down by the fire that broke out close by it some time ago, and threatened to lay hold of it; but was, unfortunately, laid hold of itself, and arrested before it could perform the good office of ridding us of that scandal to City-taste. Pity that that taste is more Apician than Vitruvian,—that it patronises turtle soup so much, as to have no patronage left for architecture.

II. There are buildings which seem to have been intended to exemplify errors and defects, and thereby deter from anything similar being attempted. Among such monitory and well-intentioned works, we may place the front of the Royal Institution, in Albemarle-street, which looks like a huge lodging-house, with as many eyes as Argus, peeping out from between the columns of a Corinthian temple,—perhaps that of Argus himself. Instructive it may fairly be called, inasmuch as it makes manifest at a glance the utter preposterousness of attempting to unite together, as is there done, two such irreconcileable systems of composition as are those of Columniation and Fenestration. Now, I am not quite so straight-laced in my opinions as to object to an order being employed as decoration, but then it should in every case accommodate itself to the structure which is so ornamented, instead of affecting to produce the same expression as a simple open colonnade, where the columns and their entablature alone constitute the exterior of the fabric. When first seen in such a foreshortened view of it that the windows within the intercolumns are concealed, the front of the Royal Institution suggests the idea of an open colonnade upon a noble scale; but the very next minute we are undeceived, disappointed,—even disgusted. Instead of finding anything like nobleness or grandeur, we are shocked at the positive littleness and meanness which prevail in everything but the columns themselves. Not only is there a most violent and offensive contradiction occasioned by the adoption of conflicting modes and ideas, but there is no sort of keeping whatever as to style. After the columns, there is nothing whatever of Corinthianism in the other features and details. We find the most florid order applied as decoration to what is itself kept most penuriously bare; so that richness and poverty of style—or, I might say, style and no-style—are coupled together. With such absence of all artistic feeling is that pretentious façade treated, that what is meant for its decoration, causes the building itself to appear most insignificant, or even worse. Although both the columns themselves and the front are large enough, the whole is a mass of littleness and prosaic sameness; for, as if there were rather a paucity than superabundance of windows, the very doors are made to resemble the windows as much as possible: therefore, so far, the design may be said to be all of a piece throughout—yet after so unlucky a fashion, that instead of being a merit, that circumstance becomes a defect.

III. Taste is subject, not only to wholesale revolutions, but to strange fluctuations and relapses. One day we are disposed to think that taste has taken a better direction than before, and is likely to advance in it if allowed to have its free course; when, the very next, perhaps, we are startled and shocked, puzzled and perplexed, by some architectural monstrosity which runs quite counter to, and upsets our calculations. Although such is the fact, it seems hardly credible that two structures which are almost within sight of each other, and erected in the very same year, should exhibit such diametrically opposite tastes as do Bridgewater-house and Mr. Hope's new mansion in Piccadilly. The latter is such a vile compound of uncouthness and deformity, as to be nothing less than marvellous. That precious sample of design is said to be by some foreign architect,—which is the only thing to console us; yet, let whoever may be responsible for the design itself, the discredit of adopting it falls upon no other than Mr. Hope himself. Had an ignorant employer—one compelled to trust entirely to the taste and judgment of others, been prevailed upon to make choice of such a piece of studied ugliness, he would have been to be pitied, and our astonishment would have been greatly diminished. But Mr. Hope is not the man to be so imposed upon; he has the reputation—the hereditary reputation at least, of being an authority in matters of art and taste, wherefore he is almost the very last person from whom so public a display of bad taste was to be apprehended. Besides marvelling much, there is also room for fearing that, through the influence of his name, his example may become contagious, and encourage others to perpetrate similar architectural enormities. One comfort is, the building seems to be universally disliked and condemned; while the evil else to be apprehended from such example will now be greatly counteracted by the very opposite one of Bridgewater-house. What is to be regretted is, that instead of occupying as public a situation as the other, the latter mansion is comparatively secluded from notice. Even its Park-front cannot be seen very satisfactorily, all the lower part being completely screened by the garden, with its fence and shrubbery; and of as much of it as is visible, the rich and delicate detail becomes almost lost, owing to the impossibility of approaching sufficiently close to inspect it as it deserves. And the other, or south-front, which is somewhat the longer of the two, is where it is almost concealed from public observation,—Cleveland-row being no thoroughfare into the Green-park, but a mere *cul-de-sac*.

IV. Bridgewater-house puts its neighbour, "Sutherland," quite out of countenance. The two buildings contrast very strikingly with each other, and afford a very good lesson, and make manifest that decided improvement upon the whole has taken place within the last five-and-twenty years. In point of architectural quality, Sutherland-house is a very ordinary production (by two of the Wyatts); *mesquin* in its *ensemble*, and insipid and flavourless at the best. There is nothing about it that can really be called style: it has none of the stamina of style, but merely feeble, *usé* mannerism, without a single touch of genuine artistic feeling or taste, or of *con amore* diligence. Undoubtedly there are many things quite as poor, or even very much worse; therefore, if it be any praise to say that of it, to such praise Sutherland-house is unequivocally entitled. Such praise, however, is only condemnation in a milder shape; and if the structure in question is not to be called a failure, it is only because nothing more than dull *routinier* mediocrity seems to have been aimed at—and it has been produced. Apsley-house is another piece of Wyattism, and is such as to make us hope that that *ism* is now departed from among us for ever. In those days, Sansovino seems to have been quite unknown here, or else must have been put into an *Index Expurgatorius*.

V. In the subjects generally proposed to architectural students in competition for academical medals or other premiums, no very great judgment is shown, they being almost invariably of a class altogether out of the sphere of usual practice. Such subjects as royal palaces, senate-houses, cathedrals, and others of a similarly ambitious kind, do not exercise those faculties and abilities which are most of all necessary, because the opportunities for exerting them are comparatively of every-day occurrence. He who can display talent, ingenuity, and taste, on occasions which seem to afford hardly any room for displaying them, will be at no loss for ideas on more important occasions that may require him to put forth his strength, at the same time that they afford great scope for his imagination. The converse does not hold good: the production of an extravagant chimerical *projet* as an academical theme, is no pledge for the sort of talent which is really wanted, any more than the obtaining a Gold Medal is any pledge for after-distinction. Subjects so rare and exceptional that they may be ranked among the phenomena of the art, are hardly the very best preparatory themes and exercises. Even granting that they tend to develope and confirm artistic talent of a higher grade, if the talent itself be of a kind that requires extraordinary emergencies and illimitable resources for exerting and displaying it, it becómes, in a manner, a superfluous one. Unless he at the same time has powers more generally available, the possessor of it is likely to prove in the condition of Hercules employed in spinning with a distaff, at which labour his gigantic thews and sinews could have been of little service to him. Of Hercules' handiwork of that sort, no "long yarns" have been preserved as relics; but no doubt they were rather clumsy ones—as clumsy as this fantastic comparison will perhaps be considered by many. So I drop it, and resume with a fresh paragraph.

VI. Such ambitious efforts in architectural design as those above alluded to, do not at all serve to call into play what is a most valuable species of ability, that which can accommodate itself to untoward circumstances, and overcome difficulties. Where a *carte blanche* is offered, all those thwarting and fettering conditions which the architect must expect to meet and contend with, are got rid of at once. Comparatively little exertion of thought is required where what may be called dreaming will suffice. Were *carte blanche* matter of course on all occasions, imagination might be left to run riot at will. Though as to imagination, it may be doubted whether even that is much exercised and disciplined by the kind of subjects proposed for *Grands Prix* and Gold Medals. They generally show more of high-flown but empty architectural *bombast*, than of fertile invention. When examined, they may be found to be made up out of the usual stock ideas—some of them rather worn out, or at least the worse for the wear. It requires no great exertion of imagination, or power of fancy, to draw out upon paper mile-long colonnades, or spires that shall pierce the clouds. Between such mere extravagance and the artistic and poetical, there is a wide difference. Moreover, it is very possible to be exceedingly extravagant and exceedingly dull at the same time. Some of Soane's architectural "visions," as it pleased him to call them, partook of that double quality. There was enough of them as to measure and quantity, but the stuff itself of which they were formed was very ordinary and homespun—far more prosaic than poetical in texture. Schemes of such magnitude have ere now been produced upon paper, that Barry's "Palace of Westminster" would shrink into insignificance in comparison with them; yet, though the things themselves have been of monster size, they have oftener than not been made up of rather dwarfish ideas. Even empty common-place may be inflated to such bulk, as to look not only large, but solid too. But as a monster *projet* proposed by an Academy is required for producing the inflation, the bladder empties itself, and falls to the ground again. Were colossal monumental edifices reared by us every day, there would be some reason in proposing them as subjects to students; although even then they ought to be accompanied by some sort of conditions, which would have to be observed; but as such is not the case, it would surely be better to direct study with more regard to the application of it on ordinary occasions. And the talent which can display itself upon such occasions,—which is capable of elevating what seems to be a common-place subject into the spherè of art, by happiness of treatment and skilful touches,—is, though it may seem a comparatively humble, an exceedingly rare one. It is one that demands artistic feeling, and a thorough knowledge of artistic character and effect. It works out, as it were intuitively, rules for itself, which unlike ordinary technical ones, do not admit of being formally and clearly expressed in words.

VII. Ordinary rules have, no doubt, their serviceableness, but it is rather of a negative sort: the observance of them will prevent faults, but will not ensure positive beauties, or other merits than those which partake of mère routine, and are therefore equally at every one's command—of the novice as well as of the master. Rules are indispensable, since they constitute the very grammar of the art; but from its grammar to its poetry the distance is prodigious—at least, so great that ninety-nine out of a hundred never advance beyond the former so as to reach the latter. What is done by mere rules and routine, can be accomplished by one man just as well as by another. It is the something more—the undefinable and individual *non so che*, which lying beyond the reach of rules, is not to be overtaken and caught by them. As far as this finer quality of art can be studied and learnt at all, it is what every one must study for himself; for it is not to be learnt from general precepts and rules, but from a careful and diligent examination of examples marked by such felicitous quality. Rules teach *much*, but they do not teach *all*. Yet, instead of being frankly acknowledged, this is a truth which is thrust aside and kept out of sight; whereas it is one that ought to be strongly impressed upon every student. Rules and the observance of precedent will suffice for mere mechanical copying, but if architecture need not, or cannot now advance beyond that, it ought to forfeit all pretension to the character and title of Fine Art. And why should it or its followers for it be ambitious of such title, if it cannot support it by acting up to it? If we are content with it in its present condition as a mechanical art, wherefore not confess as much by calling it so, instead of claiming for it an empty title, which only reminds us of what it no longer is? As a Fine Art, all its privileges seem to be gone; therefore, they and its power being gone, it would lose nothing by being deprived of its nominal rank. This will, no doubt, be considered very harsh and unwelcome advice. Well, then, if its rank must not be given up, let us endeavour to render it worthy of such rank, and to re-instate it in its quality of Fine Art, endowed with all those prerogatives and privileges of which in these latter days it has been despoiled and stripped, and forced to subsist upon the remnants of its former treasures.

VIII. Many, it might be supposed, would be really glad, were the idea of architecture being a Fine Art to be altogether renounced, since art does not seem to be at all their element. They are safer on *dry* land—on the honest *terra firma* of practical routine. Art is a treacherous element to those unprepared for and inexperienced in it. If, according to the opinion which, though not formally expressed, is to be gathered from the remarks of certain writers, we have no further occasion for artistic invention, or any actually operating and creative principle in architecture, but may get all the art that is required for it at second-hand, and would therefore do well to confine ourselves exclusively to traditional forms and ideas,—if such be the case, and we can now dispense with art itself, we can surely dispense with the name of it. Or, if we must call it art, let us call architecture the art of making new buildings by copying or hashing-up old ones. But to affect to consider and style it a fine art, when we make it in practice just the reverse, partakes too much of quackery. Architects are now such a numerous class, that it would be strange if there were not some among them who might fairly aspire to the honourable name of artists; but the majority have very questionable claim to it, and some none at all; nor even so much as any genuine relish for their "art": and the want of earnest affection for it, is of itself a proof of the want of the talent requisite for it.

IX. Those who admire one style of architecture, are apt to be not merely indifferent to, but intolerant of every other. The lover of pure Greek architecture sees only the corruption of it in the Roman style; and of this latter, the degradation in the Italian. His standard of excellence is the Parthenon; and by that standard he tries everything else, no matter how different may be the principles upon which it is constituted. He would have Greek-Doric temples spring up everywhere throughout the length and breadth of Europe, and of America also. He is willing to extend some degree of favour to Ionic, that being at all events Grecian; but Corinthian is Roman, and shows a sad falling-off from the manly simplicity of the earlier style. On the other hand, the lover of Roman and Italian design is equally strong both in his liking and his antipathy, holding Greek architecture to be frigidly severe and monotonous, exceedingly *bornè* withal; and Gothic, together with all other mediæval styles, to exhibit only the barbarous conceits of the dark ages,—to be utterly devoid of "proportions," lawless, extravagant, and irreducible to "rules." Such at least used to be the case, for at the present day, such sweeping condemnation and insolent contempt of mediæval architecture cannot be expressed with impunity. *Tempora mutantur:* Gothic may be said to have now the ascendancy, and its admirers and devotees repay with compound interest the insults and indignities which it formerly received from the Italian school and its followers. Opposite as they are in their tastes, all these parties are alike in one respect, they being all alike one-sided, prejudiced, and intolerant in their antipathies, and cheating themselves out of much varied enjoyment by limiting the sphere of it to the compass of a single style of the art; instead of sympathising with the beautiful and intrinsically æsthetic in architecture, whatever may be the particular form under which it presents itself, or the name to which it answers.

STUDY OF MECHANICS.*

Mechanical science is certainly the most ancient branch of natural philosophy. The very commencement of existence is the exercise of force; and of all his physical powers, the first which man puts into operation is his strength: the whole business of his animal life consists in the exercise of it, and from the beginning of the world until now, every human being, from his cradle to his grave, has been making repeated experiments in that knowledge which only modern philosophers profess to teach with perfect accuracy.

Why has a study, of which the study has been universal and uninterrupted, advanced with such slow and uncertain steps? This tardy development is not the history of all other sciences. Geometry—the exact knowledge of forms and dimensions—though its applications to the purposes of life are much fewer, and much later required, became a methodic science, while mechanics still remained a crude collection of facts. So late as the end of the sixteenth century, the very simplest phenomena of falling bodies were in doubt. A heavy body falls to the ground more rapidly than a light body, said the opponents of Galileo.—The weight of the bodies makes no difference in their motion, was his counter-assertion. Now, here was a question which the world might be presumed to have settled for itself before it was five thousand six hundred years old. If there be any operation of nature more frequently observed than another, it is this very one of the descent to the ground of unsupported bodies. Yet, notwithstanding the incalculable number of previous observations, it was necessary that Galileo should appeal to direct experiment to support his views. He ascended to the top of the leaning tower of Pisa, with two balls differing very much in weight, yet both of such a density as not to be much affected by the action of the air. The balls were simultaneously dismissed from his hands, and reached the ground at the same moment, or at least without perceptible interval.

This was conclusive?—On the contrary, the discussion gained in vehemence what it lost in argumentative reasoning. Galileo's opponents were not convinced, but merely irritated. From time immemorial, it had been believed that the greater the mass of a body, the greater was the acceleration of gravity. Was it to be supposed—they asked—that they and all preceding philosophers, from the time of Aristotle, had been mistaken on this fundamental point? Rather than concede that, they chose to disbelieve the evidence of their own senses.

The momentum of mind operates as manifestly as that of matter. The difficulty which Galileo had to combat, arose not from the nature of his subject, but from the necessity of overcoming the previous tendency of men's minds, and moving them in a contrary direction. This difficulty has existed throughout the history of mechanical science: *now*, also, it is the greatest obstacle to the student's progress.

If there were no previous errors and prejudices to be overcome, no previous misconceptions to be unlearned, mechanics would be one of the most easily-acquired branches of human knowledge. If the brain were as an unwritten, unsullied scroll, ready to receive those fair characters which have been traced and perfected by the co-operation of the most stupendous efforts of human intellect—the liability to error and confusion would almost cease to exist. But this can never be the case. The student has been learning mechanics long before he commenced the study of its systematic laws. He has, as was before said, been experimenting on the subject from his infancy; and his experiments have been so crude and irregular, that almost every conclusion derived from them involves a certain amount of error.

Not until a very considerable progress be made in the study of mechanics, is the full extent of this disadvantage perceived. The science may be approached with a perfect willingness to acquiesce in its doctrines, but the perversion of undigested experience creates difficulties and prejudices which not the will merely, but great mental strength and long-continued mental habit also, are required to overcome. It becomes, then, a matter of great importance to the student to ascertain before-hand the precise nature of these prejudices and difficulties. They are manifold: and before they can be fully understood, some idea must be acquired of the character of the evidence on which the conclusions of the theory of mechanics are founded.

This evidence is of several kinds: that which will most influence the tyro—that which will always be most valid in popular estimation—is the *weight of authorities*. The testimony, however, of great names, high as it is in itself, is by far the lowest kind of evidence of the truths of mechanics. A sciolist will stop the mouths of those who know as little or less than himself, by quoting the authority of Newton, Leibnitz, Euler, the Bernouillis, Lagrange Laplace, or Poisson. The man of science cannot be so answered. To him—to no one else so much—the ideas of these master-minds are of the highest importance; but they do not work conviction. Between the effect of Newton's *dictum*, and of the greater part of Newton's *reasoning*, there exists that immeasurable difference which intervenes between a very high probability and absolute certainty In the absence of more exact information, the mere knowledge that a certain conclusion is supported by the opinion of one or more of the great founders of the science, will and ought of itself be a strong argument, but not an insuperable one. To assert that the authorities were fallible, is merely to assert that they were human, and that science is progressive.

Another, and a higher, though not the highest, evidence, is that derived from comparing the remote predictions of theory with actual observations. Let us cite an instance. Mathematicians infer from the law of gravitation, that the earth moves round the sun in an elliptic orbit, if the very small perturbations arising from the influence of other celestial bodies be neglected. This prediction as to the earth's course is so remote a consequence of theory, that it could not have been immediately foreseen—the theory could not have been shaped *merely* to meet this particular case. Now, the knowledge of the earth's actual course depends on the evidence of mere eye-sight, and may be ascertained, independently of all theory, by purely practical observations. How far, then, do these observed results verify the theoretical anticipations? "If we trace on paper," says Sir J. Herschel, "an ellipse, ten feet in diameter, to represent the orbit in which the earth is moving about the sun, and if we trace by its side the path actually described in its revolution around the sun, the difference between he original ellipse and the curve actually described is so excessively tminute, that the *nicest examination with microscopes* continued along the outlines of the two curves, would hardly detect any perceptible interval between them."

Again, it is known that the solar orbit slowly changes from age to age. The effect of this variation, Laplace showed to be that the moon moves more rapidly around the earth now than it did in remote times. This result of theory is exactly verified by observation. It has been ascertained, from the records of ancient lunar eclipses observed by the Chaldean astronomers, and subsequently by the Arabian astronomers in the eighth and ninth centuries, that the moon's mean motion is increasing by about eleven seconds in a century.

The action of pendulums, the most delicate and refined instruments used for scientific purposes, exemplifies, in a wonderful manner, the predictive power of mechanical philosophy. The earth's rotation causes bodies at the equator to be acted upon by a centrifugal force, in the contrary direction to their weight; it is clear, therefore, that their tendency towards the earth is diminished. The value of this diminution, as also of its effects on the vibration of pendulums, is determined by theoretical calculations, which take into account a large number of independent considerations—the earth's radius, spheroidal attraction, the inertia of the pendulum, the effects of thermometric expansion, the barometrical pressure, the resistance of the air; &c. By most elaborate processes, then, it is determined that the same pendulum which beats seconds in London (that is, vibrates 86,400 times in the twenty-four hours), ought to make fewer vibrations by about 140 at the equator. Also, the number of vibrations which this pendulum ought to make in various other latitudes, north and south of England, have been computed; and the results have been confirmed by observation, in a remarkable manner. Pendulums, constructed with the greatest care, have been carried from London to many places on the earth's surface, and their performances observed with extreme caution. The discrepancies observed between these results and those of theory are so minute, that no one but a mathematician would regard them; and he successfully ascertains that they arise from incidental circumstances, wholly independent of theoretical computations.

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* From the Introduction to Part I., just published, of the "Civil Engineer and Architect's Course of Mechanics, applicable to Structures and Machines." By Homersham Cox, B.A.

Such results are magnificent exhibitions of the powers of the mechanical sciences. The tests of their accuracy are immeasurably more varied, more numerous, and more minute, severer, longer continued, and executed on a grander scale, than those to which any other natural science is subjected. But the accuracy of a system is not absolutely proved by the circumstance that in any finite number of instances it leads to right conclusions. It is possible—though excessively improbable—that this accuracy is, in every case, merely the result of fortunate guesses. And this view of the subject is not so very unnatural, when it is remembered that such fortuitous anticipations, though very remarkable, are by no means uncommon, and that some of the most important laws of mechanics were wonderfully felicitous conjectures long before they were demonstrated truths.

The absolute certainty, then, of mechanical science must rest on yet higher grounds. Its supreme authority consists in this—that all its conclusions are rigorously logical inferences from indisputable elementary laws. The philosopher has a right to *demand* unreserved credence so far, and only so far, as he can establish such inferences. The demonstrative truth of his results depends on the answers to these two questions—Are the elementary laws indisputable?—Are the deductions from them rigorously logical? These are the two bases of the whole evipence. Let them be considered in their respective order, for the right comprehension of them will greatly facilitate the object proposed in the present inquiry—namely, to explain the preliminary difficulties of the study of mechanics.

First, as to the elementary laws: their peculiar characteristics constitute the very perfection of the science. In number they are so few, that *a priori* it seems impossible to build upon them any system of great extent: in nature they are so simple and apparent, that the mere enunciation of them necessarily carries with it immediate assent. These fundamental principles, regulating the minutest and the grandest phenomena of the material world, are yet detected at once on the most imperfect and careless observation of the operations of nature. They are inductions, either from the rudest, or from the most refined, experiments. Indeed, it is sometimes difficult to perceive that our knowledge of them is experimental at all, and not intuitive;—at this very moment, there are controversialists who believe them to be mere axioms or self-obvious truths, innately perceived in the mind, and not acquired from sources external to it.

And here it is necessary to establish a distinction between these fundamental laws and their ultimate causes. With the latter, the mechanical philosopher has no concern: he seeks only to ascertain and trace the *effects* of the rules by which material bodies are observed to operate on each other; but causation or speculation as to the *modus operandi*, forms no part of his inquiry. That heavy bodies are drawn towards the earth when unsupported, is a fact, of which, notwithstanding its constant occurrence, no explanation has ever yet been given. Were we not so familiar with this phenomenon, it would appear very wonderful, that one body should approach another without any communication between the two, or any visible cause of the motion. To say that it is due to the earth's attraction or gravity, is merely to give a name to, not an explanation of, the mystery. Again, who can tell what mighty, unseen chain binds this earth to move for ever in a certain orbit round a body ninety-five millions of miles distant? Planets and satellites, apparently isolated in space, separated from all other bodies by distances which the mind is utterly incapable of recognising, move on from age to age in their predestined courses; yet, so silently, that no mortal ear ever yet heard the sound of their mighty mechanism. Man, indeed, discerns its minutest operations, and from their regular recurrence learns to predict them with unfailing accuracy; but the secret agency which pervades and guides the whole system, remains an unsearched, an unsearchable, mystery for ever.

The harmonious concord of nature, however—her consistency and never-failing regularity—these are questions within the province of mathematical reasoning, and these are the questions upon which the evidences of mechanical science rest. Let it be ascertained that the laws of matter are unchangeable and universal, and a system may be founded on those laws, which can never be shaken by speculations as to their ultimate causes.

Such, then, are the *premises* from which the mechanical philosopher reasons. The only remaining question as to evidence is this—are the inferences from them rigorously logical?

The premises are obtained by induction, the inferences by deduction. The premises, as has just been said, are arrived at by comparing a great number of natural phenomena, and extracting the simple principles common to them all. This is the process of induction, which reasons by analogy from examples. All the physical sciences derive their origin from this source; for how are we to contrive a physical science—that is, how are we to reduce any class of natural phenomena to a regular system—unless by ascertaining, from nature herself, the primary laws by which she acts? It is clear, that if a man did not look out of himself, into the external world, for this elementary knowledge, his system would be nothing more than an ingenious figment of his own brain.

But the *application* of the primary laws depends on another kind of logic than that of induction. Now, we no longer reason by analogy—no longer refer to examples—no longer, indeed, draw knowledge from the external world. Nature has furnished the premises; the mind of man depends on itself alone for the inferences. These are deductive from that application of logical syllogisms to abstract propositions, which is no other than the process of *common-sense*—the very highest kind of reasoning of which the human mind is capable. It is not within our present scope to discuss the principle on which deductive reasoning depends, further than by explaining, that it may always be immediately referred, or ultimately reduced, to the Aristotelian dictum, *de omni et nullo*—what is universally true of a class of things, is true of anything in that class. It is not necessary, however, to examine minutely here this logical, or rather metaphysical, question: it is enough for our purpose that there are certain primary truths which the mind universally recognises, certain elementary methods of combining them, the validity of which is as certain to every man as his own consciousness,—and that on these primary truths and these elementary methods the inferences of mechanical science exclusively depend.

Of course, the full effect of these considerations can be perceived only in the actual study of the science itself. But we are now in position to explain the difficulties which originally retarded its progress, and which, even now, constitute the greatest obstacles to the student's progress. Geometry, it was mentioned, became a systematic science, while mechanics remained obscure and confused. If the preceding attempt to explain the foundations on which the latter science depends, have been at all successful, the reason of the earlier development of geometry will readily suggest itself. One of the elements of mechanical investigation—experimental induction—was wholly wanting in geometry. It is needless here to inquire whether any of the primary ideas of this science also be derived from experience: we may well be anxious to avoid a discussion of those essential affinities and distinctions between the objective sciences, respecting which such men as Bacon, D'Alembert, Diderot, Locke, Adam Smith, Dugald Stewart, Turgot, &c., have been unable to agree. But this is readily seen, and is of itself quite sufficient to explain the comparatively rapid development of geometry—that its progress was not impeded by difficulties incident to the advancement of mechanics—the necessity of making experiments, and of selecting, from an overwhelming abundance of results, those which, from their universality and precision, might be made the foundations of the new science.

The same difficulties occur to the student now. He approaches the study of geometry with an unprejudiced mind: whatever previous ideas of space, form, and distance he has acquired, may be confused and imperfect, but they cannot be positively erroneous. Geometry contains no secret principles, detected only by their effects; all its subjects are so obvious and palpable, that any direct mistake respecting them would be certain to soon detect itself. But of mechanics, almost every doctrine is unconsciously prejudicated before the commencement of its systematic study: here *is* a secret principle, undetected, except by its effects—an invisible agent, FORCE of which the existence is ascertained only by experience of its operations, and of which the ultimate nature is altogether unknown.

The great task, then, which the student of mechanics must perform, is to refer every problem to first principles: to refrain from appealing to his own physical notions, acquired accidentally and without method. Not that he is required to give up the right of private judgment, or subject it, unconvinced, to a fixed standard. Thus far only is he called upon to yield to the experience of his predecessors in the same pursuit—to give credence to their assertion that all the knowledge which he requires may be derived from the elementary principles which they lay down. The accuracy of those principles, and the legitimacy of the inferences from them, he must determine for himself by the effort of his own mind, independently of—if he please, in defiance of—the influence of standard authorities.

By adopting the method, here insisted upon as all-important, of referring every question to a few first principles, his science becomes a connected chain of reasoning, and acquires the two great advantages of method, certainty and facility—certainty of the accuracy of his knowledge, facility in applying it. This power, however, of tracing the mutual connection of the several parts of mechanics, and the ultimate dependence of each part upon elements common to them all, is to be acquired only by long-continued habit. There are certain practical difficulties however in the exercise of it, of which the student ought to be forewarned, and which act as snares upon his judgment; oftentimes inducing him to believe that he traces a logical consequence where none in reality exists.

Of these sources of error in the pursuit of mechanical science, the most important are included among Bacon's *idola fori*—idols or fallacies, of which the power arises in the forum or common intercourse of mankind—the defects of words—the names of non-existencies, or confused names of existencies. Language can never be so perfectly refined as to avoid entirely this disadvantage, for while the subtlety of nature is infinite, the subtlety of words is finite, and, in general, serves only to nominate general ideas, and not their minutest distinctions. In erecting the lofty edifice of science on so narrow a basis as a few elementary definitions and axioms, extreme exactness in the use of words is therefore requisite; and beautifully is it said, that when we attempt to rear a temple to heaven, we must not be unmindful of the confusion of languages.

Of no science have the principles been subject to more vehement and learned debate than mechanics; yet most of these debates have been ultimately discovered to be mere logomachies—disputes about words—which, it is therefore reasonable to suppose, would never have arisen had it been possible originally to give strict definitions of the terms involved. Perhaps the most instructive example of a learned controversy turning out to be a mere strife of words, is that respecting Vis Viva—a term retained in modern science as a mere technicality, of which the interpretation does not depend on any mechanical knowledge, but is purely conventional and arbitrary. The following account of the controversy is taken from Walton's "Mechanical Problems," a work, the value of which to the English student of the physical applications of mathematics, it would be difficult to over-estimate:—

"Leibnitz contended, in opposition to the received doctrines of the Cartesians, that the proper measure of the Vis Viva, or Moving Force of a body, is the product of the mass into the square of the velocity; the measure adopted by the disciples of Descartes having been the same as that of the Quantity of Motion—namely, the product of the mass and the first power of the velocity. This contrariety of opinion in respect to the estimation of Moving Force, gave rise to one of the most memorable controversies in the annals of philosophy; almost all the mathematicians of Europe ultimately arranging themselves as partisans, either of the Cartesian or Leibnitzian doctrine. Among the adherents of Leibnitz may be mentioned John and Daniel Bernouilli, Poleni, 'sGravesande, Camus, Muschenbroek, Papin, Hermann, Bulfinger, Kœnig, and eventually Madame du Châtelet; while in the opposite ranks may be named Maclaurin, Clarke, Stirling, Desaguliers, Catalan, Robins, Mairan, and Voltaire. * * * * The memorable controversy of Vis Viva, after raging for the space of about thirty years, was finally set at rest by the luminous observations of D'Alembert, in the preface to his '*Dynamique*,' who declared the whole dispute to be a mere question of terms, and as having no possible connection with the fundamental principles of mechanics. Since the publication of D'Alembert's work, the term Vis Viva has been used to signify merely the algebraical product of the mass of a moving body and the square of its velocity; while the words Moving Force have been universally employed, agreeably to the definition given by Newton in the '*Principia*,' in the signification of the product of the mass of a body and the accelerating force to which it is conceived to be subject: no physical theory whatever, in regard to the absolute nature of the force, being supposed to be involved in these definitions."

Technicalities expressing the elementary ideas of mechanics are *idola fori* belonging to the commencement of the science: other and different difficulties of language occur in its ultimate conclusions. Among the remote results of elaborate investigation are certain general theorems, exceedingly extensive and useful in their application; but which, if inaccurately enunciated, may be made to include cases which do not belong to them, and exclude others legitimately within their province. These difficulties may be termed questions of jurisdictions. When the language of a general theorem does not indicate with precision its jurisdiction over any particular case, or its proper mode of application to it, the only legitimate mode of arriving at a decision is by tracing the processes by which the theorem itself has been arrived at, and considering whether the particular case in question was contemplated in *them*. The general mechanical theorems have so vast and varied applications, that the bare enunciation of them, however carefully expressed, is utterly insufficient to convey to the student's mind an idea of all their consequences. Their actual operation, and the boundaries which define their power, *quos utra citraque nequit consistere rectum*, can be fully learned only by actual practice. In this respect, the science of jurisprudence presents a striking analogy. We are accustomed to reverence the common law of England as the accumulated wisdom of ages—the combination of the most subtle sagacity and the most extensive experience. But who does not know that a bare acquaintance with the general principles of law is practically insufficient for the solution of particular cases—that amidst the infinite variety of combinations to which the business of life gives rise, the abstract rule cannot be successfully applied without a certain intellectual dexterity, which long experience and constant practice alone confer?

The importance to the mechanical student of expertness similarly acquired, can scarcely be over-rated. His efforts should be incessantly exerted in the application of mechanical principles to the direct solution of problems; and it is scarcely too much to assert, that his knowledge of the science will be proportional to the number of problems which he solves. The most trivial incidents of his every-day life—every weight which he moves, every action of his muscles, suggest cases fruitful with instruction respecting the laws of force. There is not a single spot in the material world, free from the influence of force; and he has but to look around him, to discern innumerable instances in which the *rationale* of their action may be investigated, and the consequences of them predicted. This unintermitted habit of ransacking the stores of nature, of tracing the most trivial and the grandest of her operations to first principles, strengthens and confirms the power of investigation, and reduces those effects of the material laws which on a superficial view appear confused and disconnected, to one harmonious and simple system.

Another class of errors peculiarly incident to our science, is that arising from incorrectness of data—the neglect of operating causes, either from absolute oversight or from an impression that their effect is inconsiderable. The first of these mistakes will seldom be made, except by an inexperienced student; and may be altogether avoided by practice and care in conceiving the exact nature of the question before him. As a useful precaution against this difficulty, he should habituate himself to test the accuracy of his conclusions by particular instances, and by varying this test within the widest legitimate limits. If, in any one instance, his general investigations lead to an absurd consequence, they are themselves erroneous; and it will be necessary to re-examine them, and ascertain at what step the error arose.

There are more difficult cases, however, where the neglect of data arises, not from oversight, but from necessity—where the complexities of the question are such, as to render its solution impracticable without hypothetical simplifications. In all such instances, the investigator must remember that he is solving, not a question of real existence, but an artificial case—making the nearest approach to it which his powers of investigation permit. In practical mechanics, this consideration is especially important; and, as a general rule, no such hypothetical simplification should be admitted—or at least acted upon—without some estimate of the *limits of the error* which it may possibly induce.

Complicated mathematical formulæ are wholly unsuited for the practical application of mechanics, on account of the refinement and exactness of both workmanship and computation which they require. The only formulæ which the practical artisan or mechanic will *trust*, are those which he can readily apply, and which afford a margin for all the diversified circumstances of practice, unavoidable and unknown imperfections of materials, and other irregularities of detail. The method of determining results between certain limits, has the advantage of leaving such a margin, and will therefore be frequently employed in the following pages. Among its incidental recommendations is this,—that it generally gives great simplicity to formulæ which otherwise would be exceedingly complicated.

It is not within the compass of the present work, restricted in the use of mathematical language, to give a systematic development of the whole science of mechanics: its principal aim is to explain those parts of the science which are of the most direct economical importance, and to assume as little previous knowledge as possible on the part of the reader. He must be forewarned, however, that in solving mechanical problems, the difficulty does not wholly consist in determining the nature of the forces supposed to act—but, in a great degree, in ascertaining the position of the several parts of the system at which they are applied. This latter difficulty is, of course, only to be overcome by a competent knowledge of pure geometry. Galileo, the father of modern mechanical philosophy, has explained this point with like accuracy and eloquence. *La filosofia*—says he, in his SAGGIATORE—*è scritta in questo grandissimo libro, che continuamente ci sta aperto innanzi agli occhi, ma non si può intendere, se prima non s'impara a intender la lingua e conoscer i caratteri, ne' quali è scritto. Egli è scritto in lingua matematica, e i caratteri son triangoli, cerchi, ed altre figure geometriche: senza questo è un' aggirarsi vanamente per un oscuro labirinto.**

The Elements of Euclid are, and it may be safely assumed always will be, the best foundation of the study of geometry. Unrivalled simplicity and perspicuity recommend this work as an elementary treatise; its method and precision claim for it the highest position among works devoted to the exact sciences. The first four and the sixth books should be thoroughly mastered; and, above all, the intelligent student will endeavour to imbue himself with the *spirit* of Euclid,—to trace the uninterrupted current of his reasoning, from the fountain-head (the axioms and definition) to the final conclusions. It is the distinct dependence of inferences on their premises, which renders Euclid invaluable in disciplining the mind into a habit of logical and consecutive reasoning. The beginner will sometimes meet with propositions so simple and obvious, that it appears an idle waste of time to prove them—let *those* propositions be his especial study: when he has mastered their demonstrations, he will see that Euclid's intention was—not to explain trivial truths, but to show how they might be deduced as necessary consequences of *his* principles. The familiar study of this ancient work—it has stood its ground against all attempts at improvment for two thousand years—will gradually induce a mathematical habit of mind, and a right appreciation of the real nature of PROOF—of that which not merely does, but ought to, produce conviction.

As preliminary to the study of mechanics, some knowledge of the elements of trigonometry is requisite. The history of mechanical science will also affords important facilities for mastering its principles. The full value of a scientific theorem is not appreciated without some knowledge of the hard struggle by which—so to speak—it has been wrung from nature. The wanderings of the earlier mathematicians, their fruitless labours and controversies, their slow and gradual approximations to right results, reveal the subtle nature of physical truth, the narrow boundaries which separate it from error, and the necessity of maintaining those boundaries inviolate.

Dispute respecting the laws of mechanics is no longer possible. They are demonstrated; and to attempt to make them matters of controversy, is to exhibit ignorance of the processes by which they have been ascertained. "We have, therefore," it has well been said, "*no sects nor parties* in mathematics; but they abound in every other department of human opinion." And again, "In mathematical questions, where relations of quantity alone are concerned, a dispute can be completely terminated; because, from wrong premises, or false reasoning, a contradiction can be at least shown to result."

If, then, the labours which perfected the science of mechanics—for it is now perfect—have been great, if its study now task severely the highest efforts of the student's mind, are not the results commensurate? The revelations of PURE TRUTH in its most attractive forms—its manifestations in the grandest phenomena of nature, and the proudest achievements of art—these are the wages of philosophic toil. So vast are the domains of this science, that every year brings tidings of new and rich discoveries within it: while its applications to the practical wants of men are ever receiving fresh and more important developments—ever creating revolutions more extensive, more lasting, and more noble than those of politics or war.

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* Philosophy is written in that greatest of books which stands continually open before the eyes of men [that is, the universe], but cannot be learned without previous preparation to understand the language and decipher the characters in which it is written. It is written in the language of mathematics, and its characters are triangles, circles, and other geometrical figures; without which, we should wander in vain, through mazes and obscurity.

ARE WE TO HAVE AN ARCHITECTURAL EXHIBITION?

Something of the kind seems to be dawning upon us: there is what just at present looks like the prospect of such exhibition, though it may after all turn out to have been a mere unsubstantial and deceitful *mirage*. In proportion as we are anxious that the vision should be realised, we feel apprehensive of its fading away into nothing. We learn from a contemporary, that the "Architectural Association" purpose to "get up an annual architectural exhibition." Between purposing and firmly determining upon a scheme, there is a good deal of difference, more especially when the purposed "getting up" is likely to prove very up-hill work. This remark is meant not to discourage so much as to stimulate. In order to overcome difficulties, it is necessary to look them boldly in the face at once, and be prepared to encounter them.

The "Architectural Association" is a junior society, which as yet hardly stands before the public at all,—certainly not in any imposing attitude. It has no royal standard to hoist in the form of a charter—the chief privilege conferred by which seems to be that of indulging in indolence and doing nothing. Yet, if it have no charter, a junior and youthful society has, or ought to have, something greatly in its favour; for it may be presumed that it possesses zeal and energy, of both which much will be required, in order to carry properly into effect the scheme they are said to meditate. One question for consideration is, how is it likely to be looked upon by the Institute? As to the Royal Academy, that body would, no doubt, be exceedingly well pleased at a separate exhibition for architectural drawings and models being established, since they would thereby be almost entirely relieved from works of that kind, which it is evident enough they take in very reluctantly, and treat very slightingly. That the Institute would not take umbrage at that being done by a junior society which they have left undone (although their means for effecting it are as great, or much greater), is not quite so certain. Apathetical as it is, the Institute might yet feel something like awkward compunction and shame, were others to bestir themselves diligently, and venture upon an experiment which, should it succeed, would place them before the public more prominently than the Institute itself can boast of being.

The success of the experiment, however, will depend very much upon the manner in which it shall be made. If it be made at all, it is to be hoped that it will not be timidly and feebly.—And it here strikes us that we have possibly fallen into a misconception, since what the "Architectural Association" contemplates may be something very far short of the kind of exhibition that is needed. If it is to be one confined to that society's own members, instead of being open to contributors generally, and be also upon such a footing as to admit architectural subjects without distinction as to the nature and mode of them—such technical illustrations as plans, sections, and details, as well as those more pictorial representations which are the only ones received by the Royal Academy—if, we say, it is not to do this, it will fall far short of supplying a main desideratum. Resting entirely upon the abilities of the members themselves, without aid from other quarters, the proposed exhibition could hardly have sufficient stamina and substance to come properly before the public, and so as to attract notice and claim support. Neither would anything at all be done towards affording the opportunity of exhibiting their productions, to the many who are excluded from the Academy on account of the exceedingly limited accommodation there for architectural designs and models. At present, there is only Hobson's choice for architectural exhibitors,—either the Royal Academy or nowhere. And the accommodation at the Academy for works of the kind is totally inadequate; for while only a comparatively small number of them can be hung up, not above a third of them can be hung so that they can really be looked at. Therefore, what with the chance of being turned away for want of room, or else of being thrust out of sight, it is not greatly to be wondered at if many are deterred from sending anything at all. To such, other opportunity of exhibiting would be welcome; and their contributions would, it may be presumed, be equally welcome and serviceable to the "Association." Without support of the kind from others, and the extended interest so created for the success of the undertaking, there might not be attraction sufficient to produce extraction—to wit, of shillings from the pockets of the lieges. We speak merely upon our own conjecture, but take for granted that the exhibition in question would require the usual shilling passport for admission to it; because otherwise, the public would be excluded, and the exhibition be merely a private one, open only to the members and their friends, so that any good result as to diffusing a taste for architecture as a branch of design would be frustrated.

What renders it so highly desirable that a special exhibition of architectural drawings and models of every class should be established is, that productions of the kind have no chance of obtaining any attention so long as paintings are to be seen at the same place. It would be almost unreasonable to expect that they should, especially at the Academy, where the pictures are so numerous that they alone afford quite occupation enough for several visits. There, the architectural subjects are scarcely looked at at all, except just by those who make them their chief object. Let it then be fairly tried, whether, when withdrawn from its eclipse at the Academy, and allowed to display itself in a different orbit, it has really no power of attraction for the many—we do not mean the mob, but those (and they are many) who, if they possess not, affect at least to have a taste for art generally.

Supposing that the "Association" now intend to bestir themselves in good earnest, one thing which they ought especially to consider beforehand is, that architectural drawings require proportionably a much greater space for exhibiting them than pictures of the usual kind do,—because they require to be inspected as closely as miniatures or engravings; consequently, little more than the direct *line* of wall on the level of the eye can be made available for the purpose. It is of no use—rather a mere mockery—to profess, as the Academy does, to exhibit productions of the kind, and then hang the majority of them where it is only by great effort that their subjects can be made out, and all detail is completely lost. Mr. Billings—who, by-the-by, at the opening meeting of the present season, signified the Association's intention to get up the exhibition in question,—observed that he himself had no right perhaps to grumble at the Academy, because, of eight drawings which he sent in this year, seven were hung up—but four near the ceiling, and three near the floor. Considering how many subjects of his were admitted, he had reason to look upon himself as highly favoured—if it be any favour or compliment at all to have drawings received merely because their frames happen to be just the size to fit in "very nicely" with others on the same part of the wall. Such must ever be the consequence of the abominable dove-tailing system in hanging pictures and drawings, which frequently renders it necessary to put a good subject or production in an unfavourable situation, or else an inferior one in a good situation, merely because no other places where they would so well fit in can be found for them. Possibly, however, our advice may be altogether superfluous, since it is possible that the purposed exhibition will turn out to have been a mere flash in the pan.

ON A READY METHOD OF DETERMINING THE WIDTHS OF LAND REQUIRED FOR THE FORMATION OF A RAILWAY.

We will suppose the centre line to be staked out, and the distance from the top of the peg to the intersection of the slopes to be given. Let A be a centre-stake, at which the half-widths are to be determined; B, the intersection of the slopes produced; and r to 1, their ratio. The level must be placed at some point D, and the line of collimation adjusted so as to describe a horizontal plane at a distance a B above the point B (fig. 1), for a cutting. $\mathrm{BA} = \mathrm{K}$; $\mathrm{A}a = h$; $ec' = ac = h'$, the reading of the staff when stationed at c'. Then we have,

$\mathrm{B}c = \mathrm{B}a - ac = \mathrm{BA} + \mathrm{A}a - ac = \mathrm{K} + h - h'$, and the length of the horizontal line through $c' = cc' = x = r \times \mathrm{B}c = r(\mathrm{K} + h - h') = r(\mathrm{K} + h) - rh' = aa' - rh' \ldots\ldots\ldots\ldots (1)$

The horizontal distance of c' from a B, must also be measured with the chain, and this we will suppose to be y. It is evident, that at the point c', where the slope B a' meets the surface of the ground, the condition $y = x$ must be satisfied; and for no other point can it be satisfied. This point c' must be found by repeated trials.

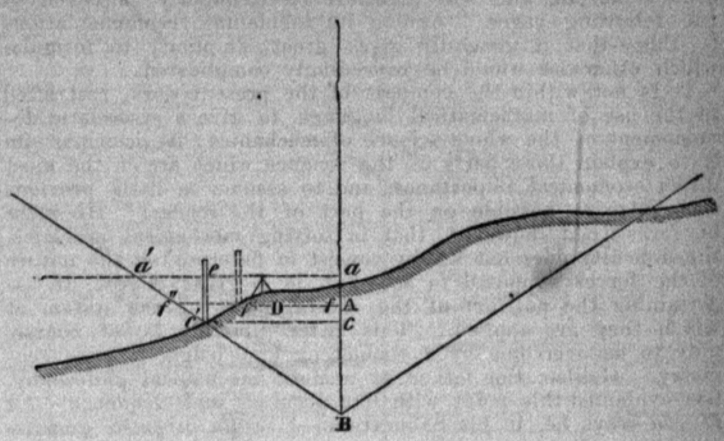

Fig. 1,—Cutting.

In the case of an embankment (fig. 2),

$$x = r \times \mathrm{B}c = r(\mathrm{K} - h + h') = r(\mathrm{K} - h) + rh' = r\mathrm{B}a + rh' = aa' + rh' \ldots\ldots\ldots\ldots\ldots (2)$$

Hence, whether there be cutting or embankment, we must determine the half-width (aa') at the *level of the line of collimation;* and in making repeated trials, we have nothing more to do than multiply the reading of the level-staff (h') for the slope by r, and add the product to aa' for embankments, or subtract it for cuttings, to obtain the value of x, which must be compared with the horizontal distance (y), found by measurement with the chain. Repeated trials must be made until a point is discovered which satisfies the condition $y = x$.

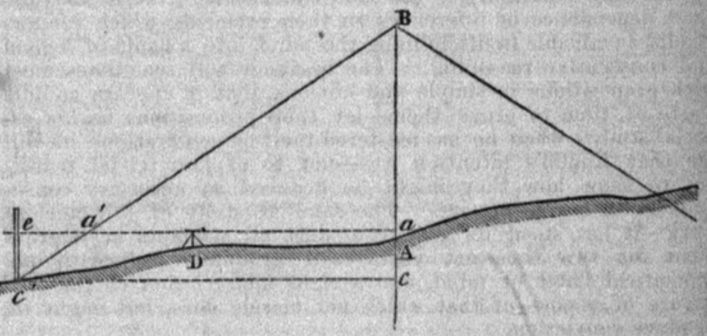

Fig. 2.—Embankment.

Take, as an example, fig. 1, which is a cutting.

$$\mathrm{BA} = \mathrm{K} = 26{\cdot}2 \text{ ft.};\ h = 2{\cdot}13;\ r = 1\tfrac{1}{2};$$

$$aa' = r \times \mathrm{B}a = r(\mathrm{K} + h) = 1\tfrac{1}{2}(26{\cdot}2 + 2{\cdot}13) = 42{\cdot}5;$$

let the staff be held at f'', and suppose the reading to be $6{\cdot}5 = h'$; then $rh' = 9{\cdot}75$; and $x = ff'' = aa' - rh' = 42{\cdot}5 - 9{\cdot}75 = 32{\cdot}75$.

By measurement with the chain, y is found $= 22{\cdot}00$;

$\therefore y$ is not equal to x.

Again, suppose the reading $c'e$ of the staff at c' to be $10{\cdot}7 = h'$; then $rh' = 16{\cdot}05$; and $x = 42{\cdot}5 - rh'$

$$\left.\begin{array}{r} = 42{\cdot}5 - 16{\cdot}05 = 26{\cdot}45 \\ \text{and } y \text{ is found by measurement to be } 26{\cdot}45 \end{array}\right\}$$

$\therefore y = x$; and c' is the point sought.

Example of an Embankment.—Slopes $1\tfrac{1}{2}$ to 1. Let $\mathrm{K} = 42{\cdot}36$; $h = 2{\cdot}43$. Then $(\mathrm{K} - h) = \mathrm{B}a = 42{\cdot}36 - 2{\cdot}43 = 39{\cdot}93$;

and $aa' = r \times \mathrm{B}a = 1\tfrac{1}{2} \times 39{\cdot}93 = 59{\cdot}9$.

Suppose the reading $c'e$ of the staff at c' to be $10{\cdot}05 = h'$,

then $rh' = 15{\cdot}07$;

$$\left.\begin{array}{r} x = aa' + rh' = 59{\cdot}9 + rh' = 59{\cdot}9 + 15{\cdot}07 = 74{\cdot}97 \\ \text{and suppose that } y, \text{ found by measurement, is} = 74{\cdot}97 \end{array}\right\}$$

then c' will be the required point.

These necessary calculations are very simple, but they are also very numerous, and I have found it advisable to substitute a kind of sliding rule, which at once performs the multiplication of r and h', and adds the product to, or subtracts it from, aa'. (*See* figs. 3 and 4.)

A long scale of equal parts (H) is formed at the edge of a groove, and another (V) slides in contact with this, as shown in the figures. H represents the horizontal measurements commonly taken with the chain, and should extend from 0 to about 150 feet.

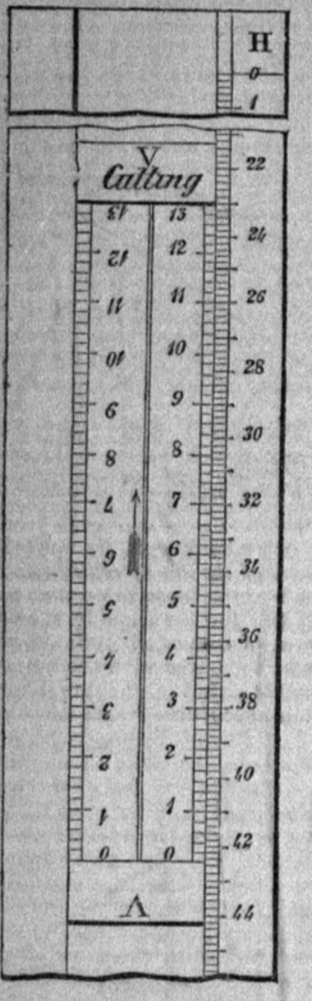

Fig. 3.
Slide arranged for determining the Width of a Cutting.

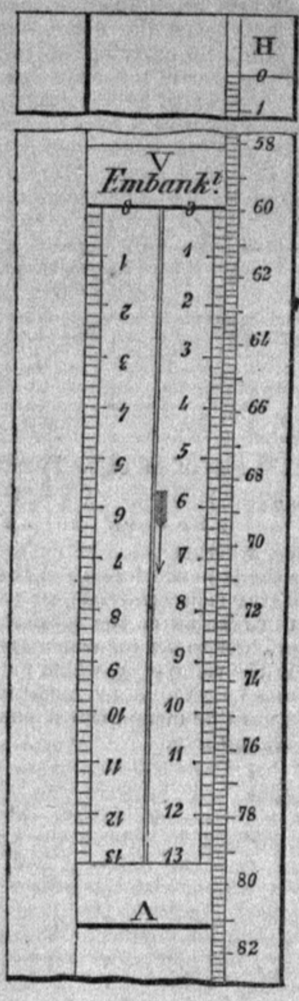

Fig. 4.
Slide arranged for determining the Width of an Embankment.

If the instrument be made of box, H may contain 10 feet to the inch, and each foot may be divided into 5 equal parts. The slide V corresponds to, and must at least contain as many feet as are marked on the levelling-staff. The scale on V, as shown in the figures, is for a slope of $1\frac{1}{2}$ to 1; for $1\frac{1}{2}$ foot on H is equal to 1 foot on V. Other slides will be required for other slopes.

In the example of a cutting previously calculated, we found that $a\,a' = 42{\cdot}5$ feet. Bring 0, on slide V, opposite 42·5 on H (fig. 3). The staff is set up at f'', and the reading is found to be 6·5. Refer to V with 6·5, and opposite this point we find $x = 32{\cdot}8$ on H, without any calculation.

But the measured distance y is 22·00 ; $\therefore$ y is not $= x$.

Again, the staff is set up at other points, and the trial repeated till we come to the point c', where the reading of the staff (h') is 10·7 feet. Refer to V with 10·7, and opposite it we find 26·5 on H, which differs only by the $\frac{1}{20}$th of a foot from the result previously given by calculation.

As $r\,h'$ has to be *subtracted* from $a\,a'$ in *cuttings*, it is necessary for the scales V and H to be numbered in *opposite* directions, as in fig. 3. But in *embankments*, $r\,h$ must be *added* to $a\,a'$, and the scales V and H must increase in the *same* direction, as in fig. 4. This is the reason why the slide has two scales, differently numbered. Fig. 4 corresponds to the numerical exámple given above for an embankment: 0 on V being placed opposite 59·9 on H; and 10·05 on V falls opposite 75 on H.

We have hitherto supposed that zero on the scale V is placed opposite $a\,a'$, the horizontal width at the level of the line of collimation. Now, the value of $a\,a'$ is dependent on the accidental position of the level, and must be calculated in the field. Suppose, however, that the half-widths at the levels of the centre-pegs have been determined, and registered previously to commencing operations. In the example of a cutting (fig. 1), we supposed B A to be $= \mathrm{K} = 26{\cdot}2$; $\therefore$ the half-width, supposing the ground to be level, $= r\,\mathrm{K} = 1\frac{1}{2} \times 26{\cdot}2 = 39{\cdot}3$; and h was taken $= 2{\cdot}13$. And the result is the same,

whether we place 2·13 (or h) on V opposite 39·3 on H,
or 0 on V opposite 42·5 on H.

The first method will be found the best, because all the half-widths at the levels of the stakes may have been previously determined in the office. The same may be said of fig. 4.

It will be found convenient to have an index capable of sliding along H, independently of V, and capable of being fixed at pleasure. This may be formed partly of a piece of horn, or other transparent substance, having a line ruled parallel to the divisions of the scales. This will be of great service where the ground is very sloping, and it becomes inconvenient to hold the levelling-staff on every peg.

If, in figs. 1, and 2, the ground had been so low that the top of the staff $c'\,e$ fell below the line of collimation, it would have been necessary to have shifted the level, and $a\,a'$ would have taken a new position and value. It will, however, be found an easy matter to determine B a, and therefore also $a\,a'$, in all cases; and 0 on V must then be placed opposite this value of $a\,a'$ on H.

Or, calculation may be avoided even in this case. Fig. 1. Suppose the first reading at a to be 2·15, and the half-width at the level of A, 39·3 feet. Bring 2·15 on V opposite 39·3 on H. Let the staff be held at any point, and take the reading 9·55, suppose. Slide the *index* along H to point to 9·55 on V.

Remove the level to a new position D', and adjust it, and suppose the back sight taken in the ordinary way to be 3·2. Move the *scale* V, so that the index points to 3·2 on V; and the instrument is adjusted for the cross-section at A, so long as the level is not disturbed.

The index will be found very serviceable where it is not convenient to commence levelling from every centre-stake. Suppose the centre-pegs to be one chain apart, and that the gradient rises δ in every chain.

We have seen that the distance B a of the horizontal plane through $a\,a'$ from B is $= \overline{\mathrm{H} + h}$ (fig. 1), as the gradient is supposed to *rise* δ feet in a chain, at a point corresponding to B; but a chain from it, the new value of a B becomes $(\overline{\mathrm{K} + h} - \delta)$;

and the new half-width $a\,a'$ becomes $r\,(\mathrm{K} + h) - r\,\delta$.

If we take an embankment (fig. 2), the new value of a B becomes $(\overline{\mathrm{K} - h} + \delta)$ at the distance of one chain;

and the new value of the half-width $a\,a' = r\,(\mathrm{K} - h) + r\,\delta$.

Thus, in a *rising* gradient, δ for every chain, we must move the slide by *the scale* H, $\left.\begin{array}{l}\text{a distance } r\,\delta \text{ upwards for cuttings}\\ \text{and a distance } r\,\delta \text{ downwards for embankments}\end{array}\right\}$

But $r\,\delta$ on the scale H is the same in magnitude as δ on the scale V, and therefore it will be most convenient to employ the index in moving the slide V upwards or downwards, through a space δ for every chain.

It may be useful to remark that for *a rising* gradient the slide V has to be moved in that direction in which the numbers of the feet on V *increase*, as denoted by the arrows, whether the case be one of cutting or embankment. If there be a falling gradient, the slide V must be moved in the opposite direction.

It will be found convenient to be provided with the height of each stake above some common datum; the half-width, supposing the ground to be level; the numbers and distances of the stakes, with particulars respecting the gradients, slopes, &c. Also, vacant columns must be prepared to receive the half-widths on each side, as they are determined, and the corresponding reading of the level. The point on H to which the zero on V is opposite, ought also to be registered. This last is very useful where a number of consecutive side-stakes are determined without starting from the centre; and doubts might otherwise arise as to whether the proper correction had been made for the gradient in every case.

As this slide-rule has been used where the ground was remarkably uneven, both for determining the widths of cuttings and embankments, and the limits of embankments at the ends of viaducts, I can strongly recommend it to the attention of those practically engaged on such work, as it avoids much trouble and uncertainty, and the result is as accurate as can be desired by the most fastidious. An addition to the widths above found must be made to allow for the ditches and fences.

St. John's College, Cambridge,
Oct. 21, 1848.

Francis Bashforth.

GEORGE STEPHENSON.

(Continued from page 300.)

[The above engraving is after a Portrait by Mr. Briggs, R.A.].

IV. THE SAFETY LAMP.

Fire-damp is one of the greatest evils happening to coal-mines, and one which is too well known to all having anything to do with them. Thirty or forty years ago, this was so strongly felt that many mines had reached their furthest workings, because the men had no good means of going on, for the least flame was enough to set the fire-damp burning, and the steel mill gave little light, and was unsafe.

In 1763, the Academy of Sciences were drawn to look into this matter, several coal-mines at Briançon, in Dauphiny, having fired. All that the Academy did was to recommend a better way of airing the mines.[1]

Above a hundred years ago, Sir James Lowther had seen that common fire-damp does not catch fire from sparks of flint and steel; and one of his overmen, said to be Mr. Spedding, made a mill for giving light by striking flint and steel.[2] This was worked by a boy, and was used in the English collieries. It is, however, known, that with the steel mill some mines have been set on fire.

In Hainault, amadou, or fungus tinder, was sometimes used; but it gives so little light, that the men could not work by it, and all that they could do was to find their way by it sometimes from one side of the pit to another, where fire-damp was blowing.

In 1796, Humboldt made a lamp[3] for giving light in mines where a common candle would not burn, or would set fire to the mine. It was founded on the plan of keeping the light away from the air, and could only burn a short time—that is, so long as the air within it lasted.

In 1813, Dr. Clanny made a lamp, to which he gave air from the mine, through water, by bellows. This lamp went out of itself in explosive mixtures. It was to be worked by hand or by machinery, but was too heavy to be moved about readily.

From what Dr. Clanny had done, and from a fearful loss of life in the Felling Colliery, whereby 101 men, women, and children died, the minds of many were turned to some way of lessening the fearful evil of fire-damp. At Sunderland a meeting was held, wherein Mr. Buddle, Mr. Dunn, Mr. Cuthbert Ellison, M.P., Bishop Gray, Dr. Clanny, and others, had a share, and who called upon Sir Humphrey Davy to search into the whole matter.[4]

Sir Humphrey looked at Dr. Clanny's lamp, but he was told it was too heavy and too costly to be useful. He tried phosphorus and the electrical light; but at length he found out that a lamp could be made air-tight, and to which the air could be sent in through very small pipes or tubes, or from small openings in wire gauze put below the flame, and having a chimney at top of the same kind, for carrying off the foul air. This he afterwards brought to bear in the shape now so well known as the Davy Lamp, or Davy, in which he was greatly helped by Dr. Faraday.

Meanwhile, others were no less busy: Mr. R. W. Brandling, Dr. Murray, and Mr. John Murray made lamps, and so did George Stephenson; and at length there was very great strife between the friends of Davy and Stephenson, as to who was the first. We have here a small book, written by George Stephenson, in his own behalf, and which is the only work of his which is printed, other than reports. Here it is well to say, that it would be worth while to print the reports of George Stephenson, to bind with those of Smeaton, for they are written in a very clear, thoughtful, and business way; and are of great worth for the history of engineering, as Stephenson was called upon to fight for the locomotive engine and the railway in their childhood, against the world, having few to back him or help him in his hard struggle.

Stephenson's book is called "A Description of the Safety Lamp, invented by George Stephenson, and now in use in Killingworth Colliery; to which is added, an account of the Lamp constructed by Sir Humphrey Davy, with Engravings. London: Baldwin, Cradock, and Joy; Archibald Constable and Co., Edinburgh; and E. Charnley, Newcastle, 1817." It is only about sixteen sides, and was printed by S. Hodgson, of Newcastle, and has four engravings.

Another very interesting book is the "Report upon the Claims of Mr. George Stephenson relative to the Invention of his Safety Lamp. By the Committee appointed at a meeting holden in Newcastle on the 1st Nov., 1817, with an appendix containing the evidence." This was printed at Newcastle, and has three plates, which are the same as in Stephenson's book.

Stephenson says: "Several of my friends having expressed a wish that I would lay an engraved plan of my Safety Lamp before the public, with as correct an account of the dates of the invention as I am able, I have resolved to do so. I was, at the same time, advised to publish the steps by which I was led to this discovery, and the theory I had formed in my own mind upon the subject, which, with the facts from which I drew my conclusions, were freely communicated to several persons during the time I was engaged in the pursuit. With this I cannot persuade myself to comply; my habits, as a practical mechanic, make me afraid of publishing theories; and I am by no means satisfied that my own reasons, or any of those I have seen published, why hydrogen gas will not explode through small apertures, are the true ones. It is sufficient, for our present purpose, that that fact has been discovered, and that it has been successfully applied in the construction of a lamp that may be carried with perfect safety into the most explosive atmosphere."

"During the four years," Stephenson goes on to say, "that I have been employed to superintend the engines at Killingworth Colliery, one of the most extensive mines in Northumberland, where there is a considerable quantity of machinery underground, I have had frequent opportunities of employing my leisure hours in making experiments upon hydrogen gas. The result of those experiments has been the discovery of the fact above stated, and the consequent formation of a Safety Lamp, which has been, and is still used, in that concern, and which my friends consider (with what justice the public must decide) as precisely the same in principle with that subsequently presented to their notice by Sir Humphrey Davy."

The first thought of the safety lamp had been long in Stephenson's mind; and in August, 1815,[5] he made a drawing of it, which was shown to several people on the works—among others, to Mr. Nicholas Wood,[6] whose name is now, for the first time, seen along with that of Stephenson. He was then a viewer at Killingworth, and seems to have taken a great share and delight in all that Stephenson did, as is shown by the works of both. Stephenson told Wood that he thought a lamp might be made which would burn the fire-damp without blowing-up. The way was this,—to make a tube in the bottom of the lamp, and he thought the attraction of the flame upwards would be greater than the force downwards. Wood drew out the plan under Stephenson's eye, and in October, 1815, they went to Mr. Hogg, a tinman, at Newcastle, and had a lamp made, which a fortnight after was put into Stephenson's hands. When Stephenson first spoke about it, he asked

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[1] Histoire de l'Academie Royale, 1763, p. 1, quoted by Davy.

[2] Hutchinson's History of Cumberland, quoted by Davy.

[3] Journal des Mines, viii. 839, quoted by Davy.

[4] See Sir Humphrey Davy's several works in 1815, 1816, 1818, and 1825, but which are nearly the same. The one here quoted is that of 1818.

[5] Stephenson, p. 7.

[6] Report, p. 16.